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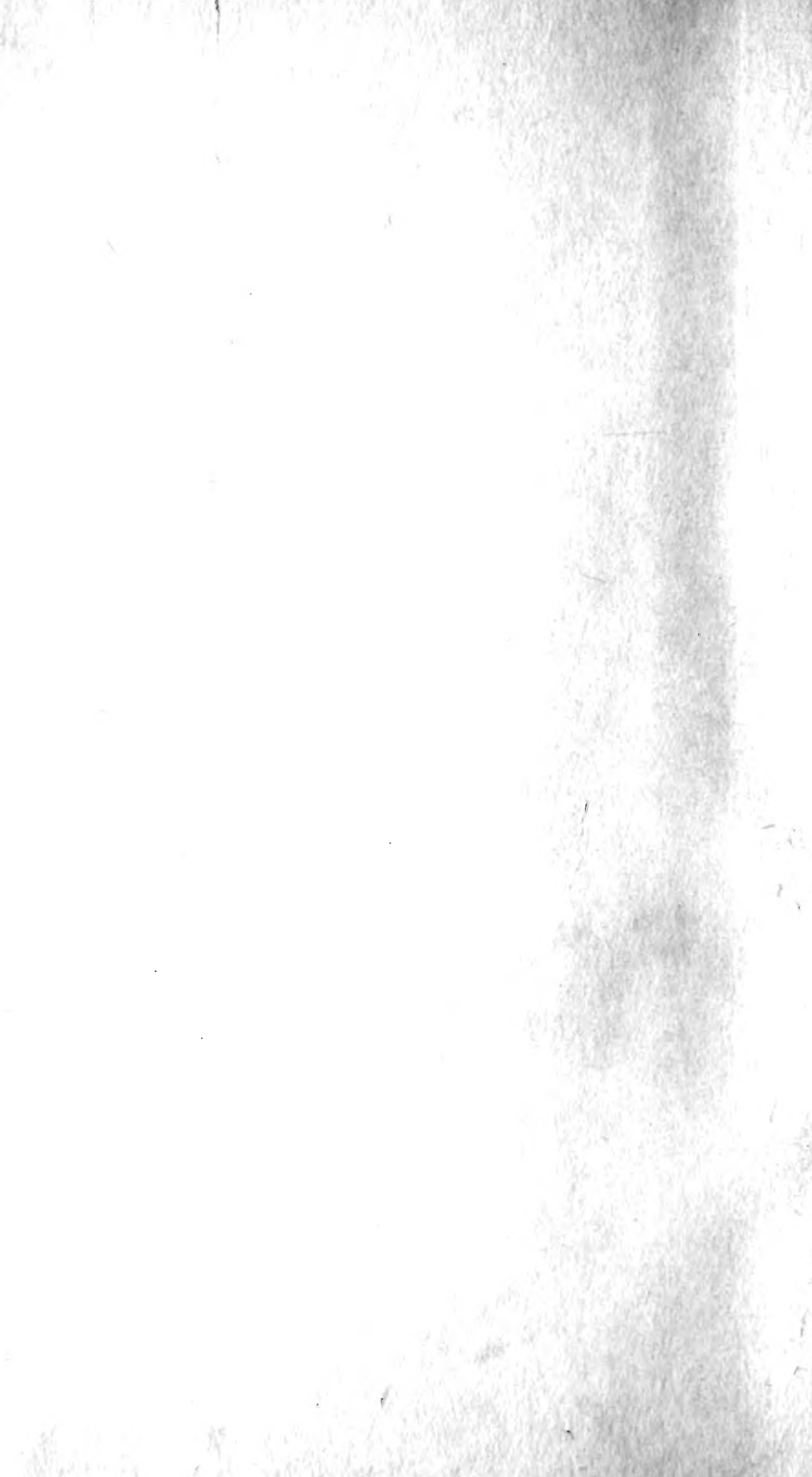
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LETTERS
ON
ENTOMOLOGY,
INTENDED FOR THE
AMUSEMENT AND INSTRUCTION
OF
YOUNG PERSONS,
AND TO
FACILITATE THEIR ACQUIRING A KNOWLEDGE
OF THE NATURAL HISTORY OF INSECTS.

LONDON:
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1825.

PREFACE.

It is not the intention of the writer of these letters to offer a *system* of Entomology, but merely a short abstract of some of the more elaborate works on that subject; which, however superior in importance, are more calculated for the scientific student, and often contain details more interesting to the physiologist than to the juvenile reader. The writer has therefore endeavoured to avoid the minuteness which might render the subject tedious, and has only to add, that her information is derived from Reaumur's *Memoires*, Shaw's Lectures, and that interesting work, the Introduction to Entomology; from which, in fact, the principal accounts are taken, and in which the discoveries of other naturalists are collected in the most attractive form.

Oct. 5, 1850 Chen
Entomology

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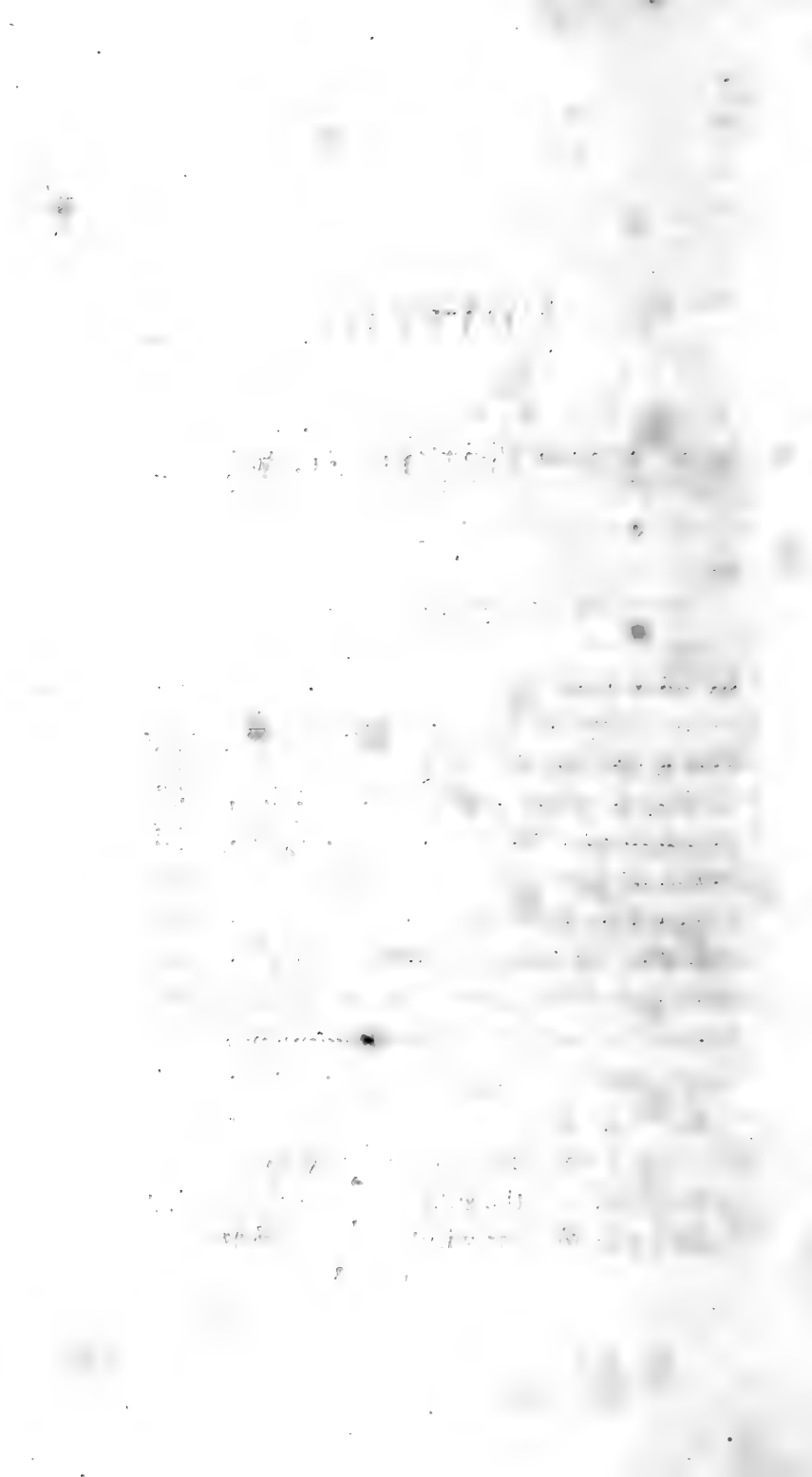
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LETTERS

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LETTERS

ON

ENTOMOLOGY.

LETTER I.

MY DEAR HARRIET,

IT has often given me great concern to observe the inconsiderate and negligent manner in which you treat, and even torment, that most beautiful part of the creation, the tribe of insects, and particularly as your disposition is most foreign to any thing like cruelty ; you have therefore, my dear, no excuse, but ignorance of their real value and beauty, or mere thoughtlessness, which, in a rational being, is of itself inexcusable.

In the course of our correspondence, I will endeavour, if you wish it, to impart the little knowledge I have on the subject, and it may perhaps induce you to treat with greater regard, beings

which are sometimes more useful than many people, who pass their lives in idleness or trifling occupations.

You may perhaps, like some others, consider the study of this part of natural history of small importance, and as a frivolous amusement; but though I should wish you to find it amusing, yet it has a higher object,—to excite admiration of the power of the great Author of so many wonders. Can we consider any thing trifling, or unworthy our regard, which it has pleased the Supreme Being to endow with such infinite variety of beauty and usefulness? If men had not long ago watched the habits, and taken advantage of the labour of insects, we should have wanted many of the luxuries and comforts we now enjoy. Who would have believed that a caterpillar, so small as the silkworm, could furnish one of the greatest articles of commerce, and give occasion to so many different arts and manufactures, enabling thousands of people to live by honest industry?

Honey and wax are without doubt most useful to us, and we should never have had them if men had not observed bees in their wild state, and made their peculiar habits subservient to their own use, by bringing them into hives.

Gum lac, of which sealing-wax is made, is produced by a winged ant; and cochineal, of which there is so great a consumption, is an insect which multiplies very fast. Even the ink I now write with, I principally owe to an insect which forms the galls of which it is made; but one of the most ancient and singular uses ever made of the labour of insects, is that of ripening figs in the Greek islands, and other Eastern countries, where the harvest of that fruit is of great consequence to the people. They plant two kinds of fig-trees, the wild and the cultivated sort. The wild tree bears fruit many times in the year, and in them grubs are born, which turn to flies. These flies are considered necessary to the ripening of the garden figs, which generally fall before their maturity, if these insects do not pierce them at the proper time. In the months of June and July, the country people gather wild figs, and stringing them on straws or sticks, place them on the garden fig-trees. They take great care every evening to look for the wild figs ready for gathering, that is, when a fly is ready to come out, and also, to observe when the other trees are properly ripe; for if the transfer is not made at the right time, the garden figs will fall. This custom

is evidently established by long experience, as the peasants anxiously watch all the rest of the year, whether the wild figs will be likely to produce flies in time, and the number of them determines the harvest of fruit. Indeed so necessary are these insects, that if they fail, the people have but one resource, which is, to spread over the trees a common plant called the ascolombros, the fruit of which contains flies fit for the purpose.

The ancients used many kinds of insects as medicine, but I shall only mention the cantharides or blister-fly, which is so useful in many disorders.

Now, my dear Harriet, let us change the scene, and consider the variety of mischief they may do us, if we do not know how to guard against them, which we shall not find easy, unless we previously know something of their habits and nature. A great number ravage not only our fields and gardens, but our houses, our furniture, and our garments; they do not even spare our persons; yet we are not to be alarmed, or fancy ourselves sadly aggrieved, if they make use of the weapons given them for their just defence; for they have certainly as much right to live as ourselves, and those who wantonly destroy them

commit a manifest act of oppression, which we should think the height of cruelty if performed upon any of the human species by a being sufficiently powerful. Therefore I would not wish you to destroy those which are merely troublesome, as many thoughtless people do, who would consider it very unjust if they were punished in the same way.

In Europe, insects are seldom dangerous, except from their number, and in that case they must be destroyed speedily ; however, the harmless kinds are by far the most common, and there is great amusement to be derived from rearing and observing them, for no species of animal undergoes such astonishing changes, or is endowed with such curious instincts. What a surprising difference is there between the crawling voracious caterpillar, and the volatile splendid butterfly, which can in many instances live without food, and is always content with the small portion of honey contained in flowers !

There is nothing more interesting than to observe their domestic habits, if I may so express myself, and the different manner in which they take care of their little families. Even those who are most disgusted with the appearance of a spider, would be pleased to see the species

which envelops its eggs in a little silken bag which it always carries about, and when the young ones come out, they climb on their mother's back and cling fast, let her run ever so swiftly.

The bees, and some kinds of wasps, feed their young many times a day like birds; and others place their eggs in cells, which they make of earth, and shut them up with a sufficient quantity of food to last till they attain maturity.

Some insects have a tender and delicate skin, which could not withstand the friction and chafing it would be exposed to, and therefore nature teaches them to make real garments, some of wool, some of silk, and others of leaves and different substances; some make them longer and larger as they increase in size, and others make new ones.

I remember seeing on a vine in the greenhouse, a singular whitish insect with six legs, bearing a roof of particles of mortar and earth seemingly combined with some glutinous substance, and the little creature ran briskly along under its load, completely covered and defended.

If you find the subject amusing, I will continue my correspondence soon; till then adieu.

LETTER II.

MY DEAR HARRIET,

As it is a common error to suppose that because things are small, they are of no importance, and as perhaps you may be of this opinion, I will endeavour to convince you that it is wrong; and therefore I will tell you some of the *harm* they can do when permitted. If they had no checks, we, and all the larger animals, should soon be driven from the earth, and insects of all kinds reign paramount. This is no exaggeration, as you will perceive, when I disclose but a small part of their destructive powers.

Nothing is free from them—neither the cunning, the swiftness, the strength, the ferocity, nor the bulk of animals can protect them; even man himself is sometimes their prey. They are often swallowed, and, living in the inside, cause mortal diseases. Some people have even been devoured alive, as it were, by swarms of mites, for which there was no remedy. Among our personal assailants we may notice the red *Acarus*,

mentioned by Ulloa, common in Popayan, called coya, or coyba, the venom of which is so malignant, that if it is only crushed on the skin, it penetrates the flesh and raises large tumours, which are soon followed by death; it is described as much smaller than a bug.

As to the fly tribe, you will not deny their power of becoming a real plague. What would you think of any large animal coming to attack you with a tremendous apparatus of knives and lancets issuing from its mouth? Yet the horse-fly, and many others which have instruments resembling all kinds of murderous weapons, attack you, and, forming a siphon or pump of them, suck your blood with the greatest voracity. Of all these little torments, the gnat species is the worst. They may be truly said to have their sting in the mouth, since the pain and swelling of the bite show that they inject poison. This weapon is composed of five pieces besides the sheath, some of which appear simply lancets, while others are barbed like a bee's sting, and are adapted both for making the wound, and forming a siphon to draw out the blood.

Although with us, they are rather teasing than absolutely injurious, yet when they come in great numbers they are a true plague. In the

year 1766, in the month of August, they appeared in such incredible numbers at Oxford as to resemble a black cloud darkening the air. One day a little before sunset, six columns were observed to ascend from the boughs of an apple tree, some in a perpendicular and others in an oblique direction, to the height of fifty or sixty feet. Their bite was so poisonous that it was attended by violent and alarming inflammation, and one, when killed, usually contained as much blood as would cover three or four square inches of wall.

The poor Laplanders are the most to be pitied; they are obliged to live in suffocating smoke, either to eat or sleep, and the insects abound so much that they cannot breathe without drawing them in. Reaumur tells us that in some parts of France he saw people whose legs and arms were so swelled and inflamed with gnat-bites, that it was doubtful whether amputation would not be necessary. In the neighbourhood of the Crimea, the Russian soldiers are obliged to sleep in sacks, to defend them from the mosquitos; and even then, many die in consequence of mortification produced by the bites of these furious and blood-thirsty insects. Dr. Clarke, who relates it likewise, says, that in

spite of gloves, clothes, and handkerchiefs, his body, and those of his companions, were rendered one entire wound, and that the irritation and swelling excited a considerable degree of fever. In a most sultry night, when not a breath of air was stirring, exhausted by fatigue, pain, and heat, he sought shelter in his carriage, and, though almost suffocated, dared not open the window. Swarms nevertheless got in, and, in spite of the handkerchiefs with which he had bound up his head, filled his mouth, nostrils, and ears. In the midst of his torment he lighted a lamp, which was extinguished in a moment by such a prodigious number, that their carcasses filled the glass chimney and lay in a large heap over the burner. Can you conceive a much more disagreeable and tormenting situation?—Captain Stedman says, that in America, his soldiers were obliged to sleep with their heads thrust into holes in the earth, and their necks wrapped round with their hammocks. Humboldt informs us that between the little harbour of Higuerote, and the mouth of the Rio Unare, the wretched inhabitants are accustomed to stretch themselves on the ground, and pass the night buried in the sand three or four inches deep, leaving out the head only, which they cover with a handkerchief.

We likewise learn from him that there are three kinds: the Mosquitos, flying in the day; the Temporaderos, flying in the twilight; and the Zancudos, in the night; so that these unfortunate beings have no respite from their tormentors, which make almost uninhabitable all places where they particularly abound. After this account we cannot be surprised that they have given their names to bays, towns, and countries. There is Mosquito Bay, in St. Christopher's; the town of Mosquitos, in Cuba; and the Mosquito country, in North America; which are sufficient and melancholy proofs of their importance. Of all insects the locust is the most celebrated, for its powers of destruction, and dreaded more than an army of wild beasts; yet this insect is not large, and is only herbivorous. Figure to yourself a country so covered that the ground cannot be seen; *all* its produce devoured, and not the least vestige of herbage left. In the year of the world 3800, Africa was infested by such infinite myriads of these animals that, having devoured every thing green, they flew off into the sea and were drowned; where, being cast on the shore, they emitted a stench greater than could have been caused by the carcasses of an army. St. Augustine mentions a plague arising from the

same cause, which destroyed not less than 800,000 persons in the kingdom of Masinissa alone, and many more near the shore.

A historian quoted by Mouffet, relates that in the year 591, an infinite number of locusts, unusually large, ravaged part of Italy, and being at length cast into the sea, their stench caused a pestilence which carried off near a million of men and beasts. The same occurrence is said to have taken place in the Venetian territory, though to a smaller extent. They have even reached as far as France, and in 1748 they were observed in England, with great alarm, but providentially they soon perished. These were evidently the stragglers from the vast swarms which in the year before ravaged Wallachia, Moldavia, Transylvania, Hungary, and Poland. One of these swarms which entered Transylvania, in August, was several hundred fathoms in width (at Vienna the breadth of one was three miles), and extended so far, as to be four hours in passing over the Red Tower; and such was its density that it darkened the air to so great a degree, that when they flew low, a person could not see another at twenty paces! Can we wonder at their being objects of terror, when the very account of them is enough to make one shudder? A gentleman

in India saw the immense army of locusts, which ravaged the Mahratta country. The column extended near five hundred miles, and darkened the sun so much that no shadow was cast by any object. This was a red species, which made it still more horrible; for after they had stripped the trees, they clustered upon them, giving to every thing a sanguine hue.

Of the noise they make, and their terrific appearance, the prophet Joel has given a correct and sublime description: "A day of darkness and of gloominess, a day of clouds and of thick darkness, as the morning spread upon the mountains: a great people and a strong: there hath not been even the like, neither shall be any more after it, even to the years of many generations. A fire devoureth before them, and behind them a flame burneth: the land is as the garden of Eden before them, and behind them is a desolate wilderness; yea, and nothing shall escape them. Like the noise of chariots on the tops of mountains shall they leap, like the noise of a flame of fire that devoureth the stubble, as a strong people set in battle array. Before their faces the people shall be much pained: all faces shall gather blackness. They shall run like mighty men; they shall climb the wall like men of

war, and they shall march every one in his ways, and they shall not break their ranks; neither shall one thrust another, they shall walk every one in his path: and when they fall upon the sword they shall not be wounded. They shall run to and fro in the city; they shall run upon the wall; they shall climb up upon the houses; they shall enter in at the windows like a thief. The earth shall quake before them, the heavens shall tremble: the sun and moon shall be dark, and the stars shall withdraw their shining!" He further says, "I will remove far off from you the northern army, and will drive him into a land barren and desolate, with his face toward the east sea, and his hinder part toward the utmost sea; and his stink shall come up, and his ill savour shall come up because he hath done great things."

Locusts usually migrate from south to north, passing from the deserts of Arabia, which is the great cradle of them, to Palestine, Syria, Carmania, Natolia, Bithynia, Constantinople, Poland, &c.

Can we ever be sufficiently thankful, my dear friend, that we are not visited by this terrible scourge? If we had once felt the consequences, we should doubtless be more sensible of our

happiness in living in a country where every evil of the kind is comparatively slight; yet even here whole crops are sometimes destroyed by other insects. That most important plant, wheat, has many assailants; one of the earliest is a grub which eats into the plant, about an inch below the surface of the earth, devouring the middle, which soon kills the plant. The larvæ of a particular kind of beetle cause great destruction in a similar manner; and, not content with this, the perfect beetle itself afterwards attacks, by night, the grain when in the ear. The far famed *Hessian fly* which spreads such dismay wherever it appears, and made such ravages in North America that it threatened the total destruction of the culture of wheat, was erroneously supposed to have been carried there from Germany by some Hessian soldiers. It commences its operations in autumn, as soon as the plant begins to appear above ground, when it devours the leaf and stem with equal voracity, until stopped by the frost. When spring returns, the fly appears again and deposits its eggs in the heart of the main stem, which it perforates, and so weakens, that when the ear begins to grow heavy and is about to pass into the milky state, it breaks down and perishes. All the crops, as far

as they extended their flight, fell before them. They first appeared in Long Island, from whence they proceeded inland at the rate of fifteen or twenty miles annually. Nothing intercepts their career; they were seen to cross the Delaware like a cloud; and their numbers were so great, that in the wheat harvest, five hundred were counted in a single glass tumbler, exposed to them a few minutes with some beer in it. When laid up in the barn or granary, the grain is often attacked by the Weevil, in its perfect as well as grub state; and this pest increases incredibly, for a single one will produce in one year 6000 descendants.

Another very destructive species to plants in general (and which, indeed, comes next to the locusts), are the aphides, or plant-lice, which multiply so prodigiously as to cause great injury. In five generations one aphis may produce 5,904,900,000 descendants, and Reaumur supposes that in one year there may be twenty generations. Pease and beans are greatly injured by them, and in the year 1810, the produce was not much more than the seed sown: however, by being sown earlier, the pease have some chance of escaping.

How dull would our beautiful meadows look

if stript of their green carpet ! but they would soon be deprived of it, if their despoilers were permitted to increase like some other insects. The larvæ of the cockchafer (*scarabæus melolontha*), which remain in this state four years, sometimes destroy whole acres of grass. They undermine the richest meadows, and loosen the turf so much, that it will roll up as if cut by a spade. These grubs did so much injury about seventy years ago to a poor farmer near Norwich, that the court of that city, out of compassion, allowed him £25 ; and the man and his servant declared they had gathered eighty bushels of the beetle. They do not confine themselves to grass, but eat also the roots of corn ; and it is to pick up this grub, of which swine are likewise very fond, that the rooks follow the plough.

I suppose you will exclaim, What ! is there no remedy or defence against all these little destroyers ? I fear there are not many very effectual ones ; but I was amused at the plan of Mr. Rodwell, of Barham Hall, whose wheat-fields were ravaged by a small gray slug. Having heard that turnips had been successfully employed to entice the slugs from wheat, he had the land strewed with sliced turnips, and the next morning the poor little slugs were all taken in the

trap, and picked off: near a bushel was gathered. I suppose you have heard enough of the disagreeable qualities and tormenting propensities of our little enemies, though I have told you but a very small part of them. In my next letter I shall take a less gloomy view of the subject, in the consideration of the benefits they bestow on us; till then adieu.

LETTER III.

MY DEAR HARRIET,

I THINK I cannot begin this letter better than by quoting the words of the author of the *Introduction to Entomology*: "God, in all the evil which he permits to take place, whether spiritual, moral, or natural, has the ultimate good of his creatures in view. The evil that we suffer is often a counter-check, which restrains us from greater evil, or a spur to stimulate us to good: we should therefore consider every thing not according to the present sensations of pain, or the present loss or injury that it occasions, but according to its more general, remote, and permanent effects and bearings;—whether by it we are not impelled to the practice of many virtues, which otherwise might lie dormant in us—whether our moral habits are not improved—whether we are not rendered by it more prudent, cautious, and wary, more watchful to prevent evil, more ingenious and skilful to remedy it;

and whether our higher faculties are not brought more into play, and our mental powers more invigorated, by the meditation and experiments necessary to secure ourselves. Viewed in these lights, what was at first regarded as wholly made up of evil, may be discovered to contain a considerable proportion of good."

A few facts will convince us of the justice of these remarks. In countries where vegetation is luxuriant, even the locusts are of use to clear away the superabundance of some individual species. Sparrman remarks, that a region which had been choked up by shrubs, perennial plants, and hard, half-withered and unpalatable grasses, after being made bare by these scourges, soon appears in a far more beautiful dress, clothed with new herbs, superb lilies, and fresh annual grasses, and young juicy shoots of the perennial kind, affording delicious herbage for the wild cattle and game.

When in moderate numbers, the grubs, which feed upon grass, only devour so much as to make room for new shoots, and consequently hinder the roots from being matted. There are many similar instances, but the ways in which they are most beneficial to us, are by removing all dead and decaying substances; supplying food to useful animals, as fish and birds; and devouring

other insects, which, by their multiplication, would become hurtful to us.

What a scene would the face of Nature present, if Providence had not provided for the removal of the numberless dead carcasses which would strew the earth, and cause the most fatal and noisome effluvia! As soon as life departs, the carcass is attacked by myriads of insects. The *Histers* pierce the skin; next the flesh-flies cover it with their young, already hatched, and millions of eggs: how quickly these grubs will despatch it we may judge, when we consider that one flesh-fly will lay 20,000 eggs, and the grubs will devour enough in twenty-four hours to make their weight increase two hundredfold! Can you imagine such little gluttons? Linnæus asserts, that three of these flies will devour a dead horse as fast as a lion would, and it seems very likely. The beetles come next; wasps, hornets, and even ants: the horns of animals have a particular species of insect which inhabit and feed upon them.

The *necrophorus respillo*, or burying beetle, inters the bodies of small animals even of the size of mice and frogs. M. Gleditsch put four of these insects into a glass vessel half filled with earth and properly secured, and upon the earth

he placed two frogs. In less than twelve hours one of the frogs was buried by two of the beetles ; the other two ran about the whole day, as if busied in measuring the dimensions of the remaining corpse, which on the third day was also found buried. He then put in a dead linnet, and a pair soon began, by throwing the earth from under it, and pulling at the feathers from below. The male having driven the female away, continued the work for five hours, digging underneath, then mounting on it to tread it down, then retiring below to pull it down. At last, quite tired, it came out and leaned its head beside the bird upon the earth for a full hour, and then again set to work. In two days the bird was completely buried. The object of these industrious insects is by this means to procure food for their young ; for if the bodies are dug up in about six days, they will be found swarming with maggots. M. Gleditsch continued to add other small dead animals, which were all sooner or later buried ; and the result of his experiment was, that in fifty days four beetles had interred, in the very small space of earth allotted to them, twelve carcasses : viz. four frogs, three small birds, two fishes, one mole, and two grasshoppers, besides the entrails of a fish, and two morsels of

the lungs of an ox. Is not this surprising? It is rather singular that the male should partake the labour with the female, which in the insect world is a very rare occurrence.

Nothing is more unwholesome than the effluvia of decaying vegetable matter, and in removing this, our little friends render us an important service. It is very curious that stagnant water, which would become putrid without, is made sweet and wholesome by the innumerable larvæ of gnats, ephemeræ, and other insects which live in it. Linnæus's experiment easily proves this: if two vessels are filled with putrid water, leaving the larvæ in one, and taking them out of the other, the first will be found pure and sweet, and the other will remain in its impure state. The wood-destroying insects are highly useful in countries overspread with immense forests, where lightning and hurricanes make such devastation; yet no traces of the ruin are to be found, though some of the gigantic tropical trees are almost impervious to the action of the elements. They, however, soon disappear under the destroying operation of insects. As soon as a tree falls, one tribe attacks its bark, and thousands of holes are bored into the trunk by others. The rain thus finds access, and assists the decay.

Mr. Smeathman tells us, that the Termites will in a few weeks destroy and carry away the trunks of large trees, without leaving a particle behind; and in places where two or three years before there has been a populous town, if the inhabitants have abandoned it, there will be a very thick wood, and not a vestige of a post to be seen.

You may easily imagine that if these kinds of insects, though so useful in some cases, were permitted to increase very much, we should not have even a gate or a post; but they are kept in due bounds by the number of enemies which make them their prey. Some are insectivorous only in the larva state, others only in the perfect state, others in both states, and others in all three. The parasitical insects feed upon the living creature, and only destroy it when they attain their full growth; the imparasitical ones are those which prey upon dead insects, or kill them. The most beneficial of the latter race are those which devour the aphides or plant-lice. The larva of a beautiful fly is one which has a pair of long crooked mandibles perforated, and serving instead of a mouth; with these it sucks the aphides without mercy, and the individuals of one species even clothe themselves in the skins of their victims. Another grub,

furnished with a singular mandible like a trident with its three points, lies on the leaf of a twig covered with the aphides, and groping about, soon finds one, which he transfixes with this trident, raises into the air and devours; thus rendering a great service to the tree, which, when cleared of its destructive visitors, is enabled to put forth new shoots. The most important, however, is the pretty little lady-bird, or *coccinella*, which, in the larva state, feeds entirely on the aphides, which, under the name of the *fly*, cause so much damage to the hops. In 1807 the shore at Brighton, and at all the watering-places on the south coast, was literally covered with them, to the great surprise of the inhabitants, who did not know that they came from the neighbouring hop-grounds, where they had done good service in their larva state.

The parasitical insects all lay their eggs in living subjects, in the larvæ, the pupæ, and even in the egg; but none are known to do it in perfect insects. This numerous race are called ichneumon flies, from their analogy to the Egyptian ichneumon, which was supposed to destroy the serpents, and eat the crocodile's eggs. These flies have a long pointed tail, with which they pierce a hole sufficiently deep for the egg, and it

is in vain the victim seeks to avoid the fatal wound; the merciless fly does not leave it till she has deposited a sufficient number of eggs, and the poor caterpillar is forced to carry about her mortal enemies, which feed on her inside but never touch her vitals, though they are frequently in great numbers.

Of thirty cabbage caterpillars which Reaumur put into a glass to feed, twenty-five were fatally pierced by an ichneumon; from which we may judge of the great destruction of these injurious insects, which if suffered to increase, would become as great a plague as the locusts, and indeed have frequently been known to do serious damage.

I cannot here enumerate all the species which prey upon each other, but I will mention some of the principal among those which devour the perfect insect. Ants, wasps, and hornets, are, among others, distinguished in this sanguinary or rather warlike respect; an ant will carry away a bee many times bigger than itself, and has even, with the help of its comrades, been seen to drag a young snake as thick as a goose-quill. A young lady told me she once saw a battle between a wasp and a bee, in which the former bit off all her enemy's six legs. Where

1. The first part of the report is a general statement of the purpose of the study. This is followed by a brief review of the literature on the subject. The next section is a description of the methods used in the study. This is followed by a presentation of the results of the study. The final section is a discussion of the results and their implications.

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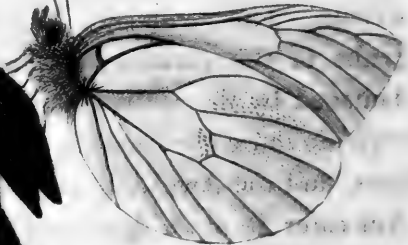
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3



Fenner sc.

1. *Papilio Cardui* - Painted Lady.

2. *P. Rubi* - Green Hairstreak. 3. *P. Crataegi* - Hawthorn Butterfly.

cockroaches abound and are a great nuisance, the white ants are very useful in clearing them away. The Mantids, which are the most terrible and ferocious of insects (though from their appearing to sit almost upright they are called praying-flies), have their fore-legs constructed like a sabre, and they dexterously use them as such to cleave their enemy in two, or cut off its head, often treating each other in this way. I believe these alarming little soldiers are not found in England. The scorpion is equally ferocious. Maupertuis put a hundred scorpions together, and a general and murderous battle immediately began. In a few days almost all were devoured by the survivors. They frequently eat their young as soon as born. Spiders are almost as fierce in their habits, destroying each other in great numbers.

Many animals feed upon insects; the hedgehog and mole are insectivorous, the latter being said to devour great quantities of the wire-worms. The swine are extremely fond of the grubs of the cockchafer, and if the grass is damaged by them, the rooting of it up will perhaps do more good than harm. The Ratel eats bees, and the Armadillo, locusts; but the great Ant-eater is most deserving of notice, for he

scratches up the ant-hill with his long claws, and putting in his tongue, which is more than two feet in length, draws it back into his mouth when covered with ants, thus devouring thousands at a mouthful. Fish live almost entirely on insects, principally on the larvæ of many kind of flies, called Caddis worms, and the perfect May-flies and Ephemera. Reaumur has given an account of the immense hosts of these last insects, which come from some of the rivers in France at certain seasons, in thousands of millions, or rather in countless numbers; they are aquatic in their first and second states, which last sometimes two or three years, though the perfect state is extremely short, some coming out after sunset, laying their eggs, and dying before sunrise, or often in a few hours. Reaumur did not see them till the middle of August, when, one evening before sunset, he got into his boat, and having detached some large masses of earth from the bank of the river, filled with the pupæ, he put them into a large tub of water and waited the setting of the sun, but he saw at this period (which was the time specified) only a few flies skimming about the water; having waited patiently till near eight o'clock, and a storm coming on, he retreated to his garden quite disappointed.

He, however, had the tub brought ; and no sooner was it set down, than a great number of ephemeræ came out, and while by torchlight he was enjoying the sight, the threatened storm burst forth, and forced him to re-enter the house, after having thrown a cloth over the tub. When the rain ceased, he returned to the garden about nine o'clock, where a magnificent spectacle awaited him. Attracted by the exclamations of his gardener, he descended to the river. The quantity of ephemeræ which filled the air above the river was inconceivably great, but principally round the spot where he stood. In a few minutes the step on which he stood was covered with them to the depth of two, three, and four inches, and five or six feet of water was quite hidden by them ; and being carried down by the current, they were quickly replaced. He was often obliged to retreat from this pelting rain of insects, which we may easily imagine to be extremely disagreeable, as they got into his eyes, nose, and mouth.

He remarks on the singularity of the great attraction of light to insects which are born to live only in darkness. The ephemeræ instantly gathered round and covered those who held the flambeaux, which then showed quite a different

spectacle, and filled with admiration even the most ignorant and stupid of his domestics: the light was surrounded with a great number of brilliant circles, formed by rows of ephemeræ, having the appearance of a scalloped line of silver, whirling round with great rapidity. Every one of these flies having made one or two circles, fell on the ground. At near ten o'clock this great cloud had almost disappeared. They had laid their eggs, and closed their transitory existence.—I cannot finish my letter without giving you the animated and poetical description of a similar scene, from the *Introduction to Entomology*.

“ I was so fortunate as to witness a spectacle of this kind, which afforded me a more sublime gratification than any work or exhibition of art has power to communicate. The first was in 1811:—taking an evening walk near my house, when the sun, declining fast towards the horizon, shone forth without a cloud, the whole atmosphere over and near the stream swarmed with infinite myriads of ephemeræ and little gnats of the genus *Chironomus*, which, in the sunbeam, appeared as numerous and more lucid than the drops of rain, as if the heavens were showering down brilliant gems. Afterwards, in the follow-

ing year, one Sunday, a little before sunset, I was enjoying a stroll, with a friend, at a greater distance from the river, when, in a field by the road side, the same pleasing scene was renewed, but in a style of still greater magnificence; for, from some cause in the atmosphere, the insects at a distance looked much larger than they really were. The choral dances consisted principally of ephemeræ, but there were also some of chironomi; the former, however, being most conspicuous, attracted our chief attention—alternately rising and falling: in the full beam they appeared so transparent and glorious, that they scarcely resembled any thing material—they reminded us of angels and glorified spirits drinking life and joy in the effulgence of the Divine favour.”

The bard of Twickenham, from the terms in which the beautiful description of his sylphs is conceived in *The Rape of the Lock*, seems to have witnessed the pleasing scene here described:

“ Some to the sun their insect wings unfold,
Waft on the breeze, or sink in clouds of gold;
Transparent forms, too fine for mortal sight,
Their fluid bodies half dissolved in light;
Loose to the wind their airy garments flew,
Thin glittering texture of the filmy dew,

Dipt in the richest tincture of the skies,
 Where light disports in ever-mingling dyes;
 While every beam new transient colours brings,
 Colours that change, whene'er they wave their wings."

I shall conclude my letter by wishing you an opportunity of seeing this delightful spectacle, which generally occurs in September. Adieu.

LETTER IV.

MY DEAR FRIEND,

I MUST endeavour to give you some idea of the peculiar characters which distinguish the class of insects from other animals. First, they are furnished with several feet, not fewer than six (for those butterflies which appear to have only four legs, have also two false ones), and sometimes with a great many. Secondly, their flesh is affixed to the internal surface of their skin. Thirdly, they breathe not by lungs or gills, but by a sort of spiracles or breathing holes, situated at certain distances along each side of the body; and lastly, the head is generally furnished with a peculiar pair of processes, called *Antennæ*, or jointed horns, which vary extremely, but are equally important organs to all.

Linnaeus divides all insects into seven orders; *Coleoptera*, *Hemiptera*, *Lepidoptera*, *Neuroptera*, *Hymenoptera*, *Diptera*, and *Aptera*. *Coleoptera* contains all insects of the beetle tribe, or such

as have strong horny sheaths (*elytra*) or covers to their wings, which are curiously folded underneath. *Hemiptera* consists of half-winged insects, which have wing-sheaths of a tough and strong substance at the upper part, and soft or membranaceous at the lower, and the real or under wings are often of great size, and plaited longitudinally, in the manner of a fan. This order contains all the insects of the locust and grasshopper tribe; the cockroaches, the lantern-flies, the Cicadæ, and many others. The common earwig is an example of it. *Lepidoptera*, the most splendid and conspicuous of all orders, consists of the scaly-winged insects; butterflies and moths belong to this order, being covered, not with feathers, as it was supposed, but small feathery or hairy scales. *Neuroptera* consists of such as have four large wings, furnished with very conspicuous nerves, fibres, or ramifications dispersed over the wing. This order is exemplified in dragon-flies, May-flies, and others. The celebrated ephemera also belongs to it. *Hymenoptera* consists of insects with four membranaceous wings, but not remarkably fibrous like the former. It contains all the wasp and bee tribe; the ichneumons and a variety of others. *Diptera* consists of two-winged insects,

as the race of flies, or *musca*, strictly so called, and gnats, with a great variety of others. *Aptera* is the last order, and comprises wingless insects. It consists, according to Linnæus, of the crab and lobster tribe, of spiders, scorpions, centipedes, monoculi, mites, and many others.

Insects pass through four states: the egg, the larva, the pupa, or chrysalis, and the imago, or perfect state. You need not be told what the first is. The second, is when they first leave the egg and are like soft worms. Linnæus calls this the larva state, and we have given it different names according to the species, as caterpillars, which are the larvæ of the butterfly or moth; maggots or grubs, which belong to the fly and beetle tribes, &c. In this state, during which they eat voraciously, and cast their skins several times, they remain different periods, some a few days, and others years. They cease eating, and fix themselves in a secure place, their skin separates, and discloses an oblong body, and thus they have attained the third stage of their existence, which is called the pupa or chrysalis. It is not a general rule that they do not eat in this state, for a considerable number, as locusts, cockroaches, bugs, spiders, &c. not only greatly

resemble the perfect insect in form, but are equally capable of eating and moving.

After remaining a certain time (some species only a few hours, while others remain months or one or more years in this state), the perfect insect bursts its case and enters on the last stage of its existence.

Look at the elegant and volatile butterfly, which seems born but to flutter in the sunbeams, and regale itself with the pure nectar of flowers. It did not come into the world as you now behold it. At its first exclusion from the egg, and for some months of its existence afterwards, it was a wormlike caterpillar, crawling upon sixteen short legs, greedily devouring leaves with two jaws, and seeing by means of twelve eyes, so minute as to be nearly imperceptible. You now see it furnished with large wings; ten of its legs have disappeared, and the remaining six are quite unlike the former ones; its jaws have vanished, and are replaced by a curled up trunk or proboscis, capable only of sipping liquid sweets: the form of its head is entirely changed, two long horns project from its upper surface, and instead of twelve minute eyes you behold two, very large, and composed of at least

twenty thousand convex lenses, each supposed to be a distinct and effective eye. I do not mean that you should think this change a *transformation*. It is in fact nothing but a series of developments, for every different skin and future form of the insect are enclosed in the caterpillar who throws them off as the parts expand. This may be perceived by dissection; the wings, rolled up into a sort of cord, are between the first and second segment of the caterpillar; the antennæ (or horns) and trunk are coiled up in front of the head, and the legs are sheathed in those of the caterpillar.

Some caterpillars pass the winter in their own form; they either make or find retreats, where they remain in a torpid state. Some bury themselves at a considerable depth, and others remain in plants and trees; these generally assemble in numbers under a silken covering. There are even some kinds of butterflies which live through the winter in a torpid state, from which they may be roused by heat. To enumerate all the different kinds would be impossible, therefore we must content ourselves with some of the most curious. The green and brown cabbage caterpillar feeds only at night, and lives underground in the day, though it is sometimes

seen out at that time. The great sphinx caterpillar is extremely beautiful, and appears quite conscious of the advantage, for it sits almost upright, and holds its head in a most conceited manner. It is of a vivid peagreen, with lilac and white stripes on the sides, and a curved horn on the tail. It feeds on the privet, and turns to a large chrysalis after burying itself deep in the ground; in the beginning of July it emerges, a large handsome moth.

All caterpillars often change their skins, and frequently come out with quite different ones. They are not always torpid in the chrysalis state, for some will spring to a considerable height and move with great activity. The chrysalis of the *bombyx dispar* (a rare moth), turns round when touched, with great quickness, but as if fearful of breaking the thread by which it is suspended, by constantly twisting in one direction, it turns back again.

A small brownish chrysalis, which is scarcely a quarter of an inch long, can jump more than an inch into the air, which in proportion to its length is a great height.

I often wondered how the chrysalis that suspends itself by its tail could effect its purpose, till I had watched its manœuvres repeatedly. Beau-

mur's description is nearly precise. The first operation of the caterpillar, when near its change, is to spin a curious little ball, or mound, of silk on the spot it has fixed on, composed of numerous little loops crossing each other. This being done, it prepares to suspend itself by its two hinder feet, which, like the others, are half surrounded by two rows of hooks of different sizes. The moment it presses these feet against the ball of silk, they are entangled among the loops. When they are safely fastened, it puts itself in a vertical position with the head downwards. It then bends its body upwards, making the back convex, and sometimes remains thus half an hour or more; this, which is often repeated, is to crack the skin on the back, that the chrysalis may come forth. The operation generally takes at least twenty-four hours, and sometimes two days; but as soon as the least crack is made, it is quickly enlarged by the chrysalis, which swells its body with an undulating motion till the skin is split far enough to discover the upper part, which is so much larger than the envelope it quits, that it is surprising how it could be contained in it; but it is the nature of the chrysalis to grow shorter and wider almost at the moment of its change. When the upper part is

all free, the next operation is to slip off the lower part towards the tail, and the chrysalis does this by swelling and contracting alternately, which pushes the skin gradually down, though some have an additional assistance in two rows of points which incline towards the tail. Thus aided, it soon pushes up the skin (for we must remember the head is downwards), and it is folded in a small packet round the place where the two hind feet are fastened. But how will the chrysalis disengage the skin, and yet remain suspended? you may ask; and indeed it seems a most perilous situation, but we must remark, that at the time of changing, the chrysalis is extremely soft and flexible; the rings or segments then perform all the functions of limbs. It seizes between the rings a part of the folded skin, and pressing them together has a fine support; then it bends its body and draws it entirely from the skin. Next it stretches itself and seizes, between the rings above those it holds by, a higher part of the skin, lets go its hold of the first, and shortens itself again; then repeats the movement, till the end of its body touches the ball of silk, and then it is suspended safely, for the end of the tail is furnished with a number of little hooks. But now having finished all

these difficult and dangerous manœuvres, it has still to get rid of the old skin, which it will by no means suffer to remain so near, and the means it uses are singular. It seizes it with part of the body, which is beyond the hooks, and then gives itself a shake, which throws it violently from side to side. It thus pulls at the skin, and the hooks on the feet break or come out of the silk, being farther from the centre of the motion than its own hooks. If the skin does not fall after this, the chrysalis rests a little, and turns in the same manner in a contrary direction: and this it is sometimes obliged to repeat four or five times. After all this trouble and pains it resigns itself to repose for more than twenty days, and then comes forth a butterfly*.

Caterpillars have many different modes of defence against their assailants; some curl themselves round as if dead, some walk or rather run away with amazing swiftness: that of the vine is remarkable in this respect. Others more courageously defend themselves by fixing half their bodies, and moving the other half in every direction, as if to seize the enemy. Others have

* The caterpillar of the *P. Io*, or peacock butterfly, changes in this manner, and comes out in eleven or twelve days.

a kind of passive defence in long stiff hairs, which quickly breaking and piercing the flesh, create great inflammation, and smart like the sting of the nettle. Lesser having touched the horn of a sphinx caterpillar, it suddenly turned round its head, and ejected from its mouth a green, viscous, and very foetid fluid, which, though he repeatedly washed his hand with soap and fumed it with sulphur, infected it for two days. The caterpillars, also, of a particular tribe of saw-flies, when disturbed, eject a drop of fluid from the mouth.

~~There is a small brown species which exactly resembles a dried stick, and holds itself erect like a little branch ; it is astonishing to see how long it will hold itself in this position, which, though it appears painful to us, may be the very reverse to the insect.~~

has the peculiar power of making a sound like the squeaking of a mouse, which is certainly the best defence it could have, as few people would like to touch a squeaking caterpillar. There is a small brown species which exactly resembles a dried stick, and holds itself erect like a little branch ; it is astonishing to see how long it will hold itself in this position, which, though it appears painful to us, may be the very reverse to the insect.

The maggot of the cheese, which turns to a black shining fly, takes amazing leaps: Swammerdam saw one, only a quarter of an inch long, jump in this manner from a box six inches in depth ; which is in the same proportion of height

as if a man six feet high should jump into the air 144 feet! He had seen others leap still higher.

Butterflies come out in the spring, and attain their full size in a very short time. This order, which is designated *lepidoptera*, consists of butterflies, hawk-moths, and moths, which are distinguished from each other chiefly by the form of their horns, or, more properly speaking, their antennæ. Butterflies have three kinds: first, those large at the extremity; secondly, those which gradually increase till near the end; and thirdly, those which are flat-sided like a ram's horn.

Moths have also three kinds: the first, nearly even to the end; the second, diminishing gradually to a point; and the third bearded or feathered; but the antennæ of the moth are always sharp pointed.

Moths fly by night, though they may sometimes be seen in dark shady places in the day-time.

There is a moth which, though not remarkable for the beauty of its colours, is so from the singularity of its form. It exactly resembles a bundle of dried leaves, and every thing conspires to aid the deception. Its colour is that of a withered elm leaf; its upper wings are veined

and scalloped at the edges; the under wings project beyond the upper, and resemble them. On the head it has a kind of beak formed by two bearded horns, which look like the leaf stalk; the antennæ, which lie backwards as far as the wings, seem the continuation of it; and, in short, the deception is complete while the moth is at rest. They are to be found in England; but we cannot be surprised that they are seldom discovered, particularly as they are very quiet in the day. The chrysalis is nearly conical in shape, and of the usual colour, but appears powdered. The caterpillar is very large, and lives on pear and peach-trees.

The death's-head moth, or *Sphinx Atropos*, is also very singular: it takes its name from the representation of a skull on its back or thorax, and was formerly regarded with great terror by the people of Brittany, who looked on it as the forerunner of pestilence. Unfortunately this insect is distinguished by the mournful cry it has the power of making; it is something like the squeak of a mouse, but more plaintive, and this increased their terror. The noise is produced by the moth striking its trunk with two bearded laminae, which are placed on each side. There is a membrane above the trunk which may have

some part in it. These moths are also found in England: the caterpillar is yellow and green, and has a strongly curved horn on the tail. Nature varies no less in size than in form, as we may see in the difference between the great Indian butterfly, which is several inches across, and the little white one which feeds on the cabbage, and is hardly so big as a pin's head, yet it has a trunk which does not roll up, but is protected by a sheath; this little creature is only three days in the form of a chrysalis.

From some kinds of caterpillars we may learn the good effects of living in harmony and fellowship. One of the commonest kinds, of which the eggs are laid by hundreds in the same place, and which come out nearly at the same time, range themselves in regular rows, and feed in perfect order, never interfering with each other; which if they were inclined to do, would make sad confusion. They also work for the public good; for as they go on eating the upper surface of the leaf, which dries and contracts, forming a kind of cavity, they draw silken threads across from side to side, till a tent is formed, into which they retire for shelter. They live principally on pear and apple-trees. These do not disperse till they have frequently changed their skin.

A more striking example is given by the oak caterpillars, which never separate even in the chrysalis state, but live together in families of five or six hundred brothers and sisters; they eat together, spin together, and repose together; only as butterflies they separate. The order of their march is the most remarkable. One goes first, and apparently any one who chooses, and the rest all follow in regular rows of two, three, four, five, &c.: they stop when the leader stops, and follow minutely every turn. The order of their march is sometimes varied, but always regular. Is not this an excellent example of the good arising from proper subordination, for how else could they continue together?

Thus we see how the caterpillars are preserved and fed, but we must now consider their enemies and misfortunes. When any species multiplies exceedingly, nature always provides against its superabundance: she produces their enemies in equal numbers, and thus the balance is preserved.

The poor caterpillars in particular have many of these; some swallow them at a mouthful, others pull them to pieces, and others suck them gradually, yet still they are very numerous. Though they appear the mildest and most helpless of insects, there is one kind which are quite

cannibals, and eat each other. Twenty of this fierce race were put into a glass box by Reaumur, and regularly fed with oak leaves. It was remarked that their number diminished daily, and yet there were no dead bodies; this excited his attention, and he observed that when one met another, it seized it with its teeth near the head, and quickly inflicted mortal wounds. Wounded caterpillars either soon die or become weak, thus the conqueror found any easy prey; and when it could not escape quietly, sucked and eat it, leaving the skin. The aggressors always appeared the strongest. Of these twenty caterpillars there only remained one, which was so greedy that it would not quit its hold of the last victim.

The most terrible enemy they have is the grub of an ichneumon fly, which lives in their insides, and is so well concealed that no one would suspect it, as the poor caterpillar looks as well as usual, though its internal parts are continually being devoured. These grubs are of two sorts—those which live in society, and those which live alone: they all undergo a metamorphosis. They are produced by a beautiful green ichneumon fly, which pierces the skin of the caterpillar, and deposits its eggs in the hole. In due time the

grubs come out through the skin, sometimes to the number of fourteen or fifteen, yet the poor insect sometimes survives, and even turns to a chrysalis, though it does not become a butterfly. The most beautiful of the cabbage caterpillars is the most subject to be attacked by the gregarious grubs, which, after their coming out, spin themselves up in cones.

If we examine the elm or oak caterpillar, we shall frequently find one or two little white patches, which are usually placed between the rings. Examined with a microscope they appear to be eggs; but they are so firmly attached to the skin, that it comes off before they can be separated. Reaumur closely inspected one which he detached with care, and found a hole on the part next the skin. He afterwards dissected the caterpillar, and found in it a large grub.

Some have these creatures outside in different parts of the body, sometimes to the number of twenty. They appear to bury their heads in the skin, and some spin their cones on the body of the caterpillar. Some flies even deposit their eggs in the eggs of the butterfly, and thus the latter are devoured before they are born.

Another formidable enemy is a black shining grub, which becomes as large as a middling cater-

pillar. It has pincers on its head, with which it soon pierces the under part, which it usually attacks, and when once fixed, there is no escape for its victim. It commonly devours as many as it finds, and generally establishes itself among those caterpillars which live in society. They are sometimes punished for their gluttony; for when they have eaten so much as to be unable to move, the young ones of their own species attack and devour them, though without any apparent reason, for they will do this when they have plenty of caterpillars.

Butterflies are also infested with parasitical insects. A young lady, one day last summer, was examining a common brown butterfly (*papilio jurtina*), and saw that on each side the thorax were some small bright red spots or tubercles. Having touched one of these with a pin, to her great surprise it came off, and ran across the paper as fast as its little legs could carry it; and on examining the others, she found that their heads were buried in the butterfly's body in the same manner as a tick fixes itself in the flesh, and she had great difficulty in dislodging them. Linnaeus says (speaking of his division of butterflies) that "the *equites* are either Troes or Trojans, distinguished by having red or blood-coloured spots or patches on each side their breasts; or

Achivi, Greeks, without the red marks." Shaw further says, that "it has been observed by some critics, that the blood-coloured spots mentioned by Linnæus as characteristic of the Trojans *are not always found.*" Now, does it not occur to you, from these words, that the red marks may possibly be these insects? I think it very probable; but I do not know whether Linnæus meant that the spots were hairy, and I wish some entomologist would ascertain and prove it.

If you are ever so fortunate as to live in the country, you may amuse yourself by keeping butterflies in a thin gauze cage, which will enable you to examine without killing them; and if you feed them with fresh flowers or honey, they will perhaps be very well contented to remain, particularly if you have a great many. They are very sociable, and will feed from your finger; but I will not answer for your being able to *tame* them, as their life is so short. It is time to finish this long letter; so, adieu! But, stay, there is one circumstance I forgot to tell you. In the West Indies there is a large larva called the grub of the palm weevil, which is as large as the thumb; it is roasted and eaten as a great delicacy. I have often heard it mentioned by a lady, who came from Demerara, who called it Grugru.

LETTER V.

I SHALL now, my dear Harriet, give you some account of an insect which is in general only known by the mischief it causes, yet is worthy of attention on other accounts. We admire, and with reason, the ingenuity which has produced such variety and beauty in our clothing, and the means by which it is done ; but there is an insect which performs the same thing for itself without any help, and in the most beautiful manner. I mean the larvæ of the moth, which are so destructive to woollen cloths, furs, &c. These caterpillars have too tender and delicate a skin to live without clothing : the habits they make are of a simple form, like a long tube, to fit their round bodies, and are made with great art. The insect chooses the woolly hairs proper for the purpose, and interweaves them with silken threads (for they are spinning caterpillars) ; the inside of this tube is lined with the same silk, and is exquisitely soft. They begin their work very soon after they are born, and are consequently obliged to

enlarge it as they grow, and this is the most difficult thing they have to do. We can easily imagine that they can add to the length, but not how they let it out at the sides. This they perform by slitting down the side about a quarter of the length (for if they did it all at once it would fall off), and putting in a little piece like a gore; they proceed with another, till they come to the end. This may be very plainly discovered by taking the insect from a blue cloth and putting it on a red one, when the additions will be all red. They have different modes of doing it, however, but all equally ingenious. Should not this make us sometimes ashamed of our own want of contrivance?

As these insects turn to moths every year, there are always plenty of their empty coats, which the young ones prefer taking to pieces for their own, to the cloth itself, as the materials are all prepared; thus those born on green or blue cloths are sometimes clothed in quite different colours, where there have been old insects before: in consequence, it is very rare to find these coats in good condition. They also show a great deal of taste; for it has been observed that, on a gray colour or brown cloth, the little creatures are dressed in bright red or blue; and on ex-

amining the cloth with a microscope, many red, blue, or green hairs have been discovered mixed with the others. They cause more destruction by mowing, as it were, the long hairs which obstruct their passage, than by what they eat.

Finally, when they have attained their full size, and the time of their metamorphosis approaches, they forsake the cloth they have lived on, and seek a more fixed and safe asylum. They fasten themselves in the angles of walls and the crevices of furniture, sometimes by one end, and sometimes by both, which they always close by a silken tissue. Thus inclosed, the caterpillar soon turns to a chrysalis, which gradually changes from light yellow to a reddish colour; and finally, in about three weeks, comes out a little gray moth.

If these larvæ are shut up with dead butterflies, they make very pretty garments of the hair and pieces of the wing.

It is worthy of remark, that they never attack wool that is not cleansed of grease, and they dislike any powerful smell. A fumigation of tobacco is fatal to them.

There is another of the same species which lives in the woods, fields, or gardens, and feeds on the leaves. These do not clothe themselves

exactly in the same way as the *domestic* sort, and their habits are not so rich and varied, but their ingenuity is perhaps still more worthy of admiration.

Though they are very common, they are seldom found but by those who know where to look, as they attach themselves to the under part of the leaf, and remain stationary; the part to which they hang is usually withered. Their garments are also of the colour of dried leaves, and thus they escape notice: they are found in oaks, elms, pear and apple-trees, and rose-trees, but rarely in the last, and each tree has a different kind.

As they are caterpillars, the body is long and round like those which eat cloth, but their garments are of a different shape. They are formed like a triangular tube, smooth and hard, and much larger than the insect, to give it room to turn round. The manner in which they accomplish the formation of them is very curious.

The substance on which they feed is the pulp between the upper and lower membrane of the leaf; and when they have eaten away a sufficient space, they lie between the two membranes, in one of which they are to clothe themselves, and cut it out as a tailor cuts out his cloth; and though the form of the separate pieces is not

square or round, or of any regular figure, but extremely irregular, yet the two pieces fit exactly. The next thing is to fasten them together, and this they do with silken threads so neatly, that the joining can hardly be discerned with a microscope. But the most remarkable thing is, that they vary their operations according to circumstances, and seldom do all alike; for instance, if the leaf is too dry to separate the membranes, they will cut it out altogether. When they grow too large for their clothes, they make new. They may be found where the leaf is transparent, with a hole.

Another kind cover themselves with little straws and dried stalks, which look very ridiculous, and have the same effect as if our clothes were covered with rows of sticks.

Land insects are not the only ones which want clothes. The aquatic kinds make them also, some of very fine sand, some of gravel, some of flat leaves, some of round stalks. Others arrange, with great taste, pieces of leaves round their coats; they appear bound with green ribbon. Others make use of every thing; fresh leaves and old rotten ones, pieces of wood new and old, gravel, small stones, pieces of shell, and even whole ones; nothing seems to come amiss.

They make themselves sometimes the most fantastical figures, but this only serves to show their ingenuity, because they do it for a particular purpose ; they are obliged to balance themselves in the water, and if too light, they put on a little stone ; if too heavy by having imbibed the water, they take a light piece of wood or straw. Some make very pretty garments by covering them with little shells, generally of very small snails or muscles.

We should be very much surprised to see a savage, instead of clothing himself with the skins of what he kills, covering himself with the living animals ; for instance, with squirrels or foxes ; yet some of these insects actually do it, and cover themselves with little muscles, well fastened on, and quite alive, though we may easily imagine it is not a very comfortable situation.

All these insects become flies with four wings : they first change into nymphs in their coat or sheath ; but as they would be liable in this torpid state to be devoured by voracious insects, they are obliged to stop the ends, which, as the water must not be excluded, they effectually do by a grating of silk.

I must not pass over those caterpillars of this species which make themselves long silken

galleries instead of having portable garments. These make great havock among the bees, and brave, under this covering, all the stings of that people of warriors. They do not seek the honey, but the wax.

These ingenious insects are all small; but who will say that they are therefore unworthy our attention? When the Author of all being has deigned to form and preserve them in so wonderful a manner, and in such infinite variety, is it excusable in us to treat his works with indifference? Are we worthy to inhabit a world so full of wonders, when we hardly take the trouble of opening our eyes to see it? I hope you will think differently, and turn your admiration from the comparatively coarse and imperfect works of art, to the exquisite and truly beautiful scenes of nature.

Believe me, &c. &c.

LETTER VI.

MY DEAR FRIEND,

OF all associations of insects, there are none that have more excited the attention and admiration of mankind, in every age, than the colonies of the hive bee. It is a subject most fertile in wonders; even the most stupid and incurious must be struck with astonishment on viewing the inside of a bee-hive. It is a little city, divided into regular streets, composed of houses, constructed on the most exact geometrical principles, some serving for storehouses, others for the habitations of the citizens, and a few much larger for the palaces of the sovereigns, made of materials which the skill of man would in vain attempt to imitate, and this is all done by insects! Well may Bonnet exclaim, "*Quel abime aux yeux d'un sage qu'une ruche d'Abeilles! Quelle sagesse profonde se cache dans cet abime! Quel philosophe osera le fonder!*"

It is not necessary, as you must be aware, that bees should have a hive; any other cavity would

serve them as well. You must have seen a honey-comb, and observed that it is a flattish cake, composed of a vast number of cells, mostly hexagonal, regularly applied side by side, and placed in two layers end to end. Several of these combs are fixed to the upper part and sides of the hive, at the distance of about half an inch from each other. Besides these vacancies, which are the high roads, there are cavities pierced through the combs, that they may not lose time by going round. If bees only constructed cells of invariable size and arrangement, it would still be a matter of admiration; but they do more. If forced by artificial means to bend their comb, they take the best means of doing it; they enlarge the mouths of the cells on the convex side, and diminish them on the other. A little reflection will show you the beauty and ingenuity of this contrivance, particularly as it is an adventitious circumstance, which in their natural state would rarely, if ever, happen.

The cells are of different dimensions, as the society consists of three orders differing in size. The cells for the male larvæ are much larger than those belonging to the workers. The queen's cell is still larger, and differs in form, being shaped like a pear, and made of a coarser ma-

terial; the situation is also different, being vertical instead of horizontal, with the mouth downwards.

The society of a hive of bees, besides the young brood, consists of one female or queen; several hundreds of males or drones, and many thousand workers. The body of the queen is much longer than the others. The drone is quite the reverse in shape, being short, thick, and clumsy. The workers are oblong, and divided into two orders, the wax-makers and nurses. They are all imperfect females like the ants. Sixteen days is the time assigned to a queen for her existence in the preparatory states, before she emerges from her cell: three she remains in the egg; when hatched, she continues feeding, or rather being fed, five more; when covered in, she begins to spin her cocoon, which is open at one end for a reason I shall presently give you. She is one day in doing this; she then reposes two days and sixteen hours, and then assumes the pupa or chrysalis, in which state she remains four days and eight hours. Four days more are required to bring the workers to perfection. There is a difference in the shape of their cocoons, for workers and drones make complete ones, while the queen's is open at the lower end, and this is probably

occasioned by the form of the cells, for if a female larva be placed in a worker's cell, it will spin a complete cocoon, and if a worker grub be put in a royal cell, its cocoon will be incomplete. No provision of the great Author of nature is in vain. As the first queen who comes out must kill all the other female grubs, it would be extremely difficult for her to do it if they were quite covered. When the prisoners are ready to emerge, they do not, like the ants, require assistance, but eat through their cocoon and cell, generally through the top. They now enter on a more interesting scene, in which the display of their wonderful and numerous instincts exceeds the most vaunted products of human skill and wisdom.

First, we must speak of the queen mother, as incomparably the most important. The first moments of her life are filled with anxiety, warfare, and peril, for she will bear no rival near her, and there are generally from sixteen to twenty royal cells in a hive, while only one is suffered to live, except when another queen is wanted to lead a swarm, in which case the workers take proper precautions. Soon after the queen's birth she visits the royal cells, still inhabited, and darting with fury on the first she meets, by means of her jaws

she makes a hole, and stings the poor female to death. The workers, who look on, then enlarge the hole, and draw forth the carcass, just emerged from the thin covering of the pupa. If her enemy is still in that state, she only makes a hole in the cell, and the workers drawing it out, it perishes. If two queens come forth at the same time, the care of Providence to prevent the hive from being despoiled of a governor is shown in a remarkable instinct, which, when mutual destruction appears inevitable, makes them fly each other as if panic-struck. They dart forward at first, and being opposite have a mutual advantage; but when their stings would give reciprocally a mortal wound, terror seems to seize them, and they fly away. The attack is renewed in the same manner till one by stratagem gains an advantage, and inflicts the fatal wound.

When another queen comes into the hive, the workers gather round her, but do not attempt to injure her. They likewise gather round their own queen, who is to fight the intruder. When she moves towards the spot, they open, to make a clear arena for the combat, and the rightful queen rushing on her enemy and seizing her in her jaws, near the root of the wings, despatches her with one stroke of her sting. Whatever

number of queens are introduced into a hive, all but one will perish, and she will have won the throne by her unassisted valour, for the workers never interfere.

If the queen dies, they have a regular time of mourning for her, which is twenty-four hours, and before that time has elapsed, they will not suffer any other to enter their domain; but after that time, they will receive any queen. If the old queen remained in the hive when the young ones came forth, she would infallibly destroy them; but this is wisely prevented by a circumstance which always takes place—the old queen leads the first swarm; and if there are more to go, the workers keep the young queens, destined to lead them, in their cells, till the proper moment: they however feed them with honey; but as fast as they make an opening, they stop it with wax. They likewise take particular care to hinder the old queen from coming near these unfortunate princesses, if we may so call them. Sometimes when angry, she stands in a particular attitude, and makes a peculiar noise or humming, which affects the bees so much that they hang their heads and remain motionless. At last she becomes violently agitated, and communicating her agitation to others, the

confusion increases till a swarm leaves the hive, which she either precedes or follows, like a sovereign driven forth by her rebellious subjects to seek a new kingdom. The bees invariably let out the oldest female from her cell first, and she becomes the soul of all their actions and centre of their instincts, though so long their prisoner. If they are deprived of her, or the means of replacing her, they lose all their activity and become quite idle. You will no doubt ask me what are the means of replacing her without a royal cell, and I will relate to you in answer one of the most astonishing, and I believe unparalleled facts in nature.

If the bees are deprived of their queen, and are supplied with the part of the honeycomb containing only the grubs of the workers, they select one or more to be educated as queens, which by having a royal cell erected for them, and being fed with the royal jelly (a particular kind which is exclusively given to queens), only for two days, come out complete queens, with their form and instincts entirely changed, though if they had remained in a common cell they would have been only workers! What shall we say to this? How can a larger and warmer cell, a different and more pungent kind of food,

and an upright instead of a horizontal posture (which is the form of a royal cell), give the bee a different tongue, make its hind legs flat instead of concave, deprive them of the fringe of hairs which forms the basket for carrying pollen; besides almost every other part of the body? Can we imagine that these seemingly unimportant circumstances can alter all its instincts and propensities, and that instead of a lively, industrious worker, it would become an indolent, tyrannical queen? If this circumstance was not established by the most credible evidence, it would be almost impossible to believe it, ignorant as we are of the general laws of nature. The first who published it was M. Schirach, secretary of the Apiarian Society in Upper Lusatia. It was communicated to the celebrated Bonnet, who long hesitated to believe it, but was at length convinced; and M. Huber, by experiments repeated for ten years, was fully convinced of the truth of it. Indeed it had been practically known long before, for M. Vogel asserts, that experiments confirming this extraordinary fact had been made by more than a hundred different persons in the course of more than a hundred years, and that he had known old cultivators of bees who had assured him that if proper measures were taken, in a practice of

more than fifty years, the experiment never failed. Signor Monticelli, a Neapolitan professor, informs us that the Greeks and Turks know how to make artificial swarms, and that the art of producing queens at will has been known, in the little Sicilian island of Favignana, from very remote antiquity. I have been so particular in giving all this authority, my dear Harriet, because people in general are very apt to doubt what *appears* strange, merely because they do not comprehend why or how it is, forgetting that they are neither omniscient nor omnipresent.

Reaumur says that the best sign that a hive is preparing to swarm, is when on a sunny morning few bees go out of a hive. A good deal depends on the state of the weather, however, to accelerate or retard it. Another sign is a general hum in the evening, and which continues even in the night. The old queen leads the first swarm, and the first-born of those left, or the princess royal, if we may so call her, probably takes her place. The longest interval between the swarms is from seven to nine days, and between each successive one it is much shortened.

If one of the antennæ of a queen is cut off, it seems not to affect her ; but if deprived of both,

she appears in a kind of delirium, and without her usual instincts, yet the respect of her subjects is the same. If two mutilated queens meet, they show not the slightest symptom of resentment. These antennæ appear to be extraordinary instruments of perception. The poor drones have a short life and a tragical end, for the eggs that produce them are usually laid in April or May, and they are stung to death by the workers in July or August. However, as they are quite idle members of the community, and do nothing but eat, it would not be proper that they should live all the winter to consume the labours of the industrious. We must remark that in hives deprived of their queen they are suffered to remain alive. I must defer any further account till my next letter, when I shall tell you something of the workers, those lively and interesting visitors, who disdaining all but the sweetest productions of nature, live in flowers and feed on nectar, and whose cheerful hum insensibly enlivens our summer walks. Adieu for the present.

LETTER VII.

I SHALL not pretend, my dear Harriet, to give you a full and circumstantial account of all the history of bees, but shall only mention such things as I consider more particularly worthy of attention; though even the most trivial circumstance shows the wisdom and perfection in which all nature is made.

The principal object of the working bees in their excursions, is to obtain three things: the nectar of flowers, from which they make honey and wax; the pollen or dust of the anthers in flowers, of which they make bee bread, which is their food; and the resinous substance called by the ancients *propolis*, and used in various ways in rendering the hive secure, and finishing the combs. The first is the pure fluid in the nectaries of flowers, which they lick up with their long tongues; for you must remark the bee's tongue is not a tube to suck with, but a real tongue, which laps or licks the honey, and passes it to the first stomach, which is called the

honey bag. When the bee returns to the hive, she regurgitates it in the form of pure honey, into one of the cells prepared. When the stomach of a bee is filled with nectar, she next, by means of the feathered hairs on her body, gathers the pollen from which the bee-bread is made, and which we may call the ambrosia. When her body is covered with this dust, she wipes it off with the brushes of her legs, not to disperse it, but to knead it into two small pellets, which she carries in the baskets formed by the hairs crossing each other, on her hind legs.

Many authors assert that the bee never visits more than one species of flower in each journey from the hive; and this appears most probable and reasonable; for the grains of pollen would not, most likely, adhere together if not of the same kind; and the pollen which the bee would carry into the flower might make the seed of a different kind, and there would be no perfect flower in time.

The bee, on her arrival at the hive, either eats the pellets of farina, or calls others to her assistance. They store up the superfluous part in empty cells.

The propolis is collected from the buds of trees, particularly from the poplar. Huber

planted some twigs of a species of poplar : before the leaves were out, and almost directly, a bee alighted, and opening a bud, drew from it a thread of the viscid matter contained in it, and with its legs placed it in the basket of hairs. Their scent is remarkably acute, which Huber proved by putting some honey behind a window-shutter, whence it could not be seen, leaving the shutter just open enough for insects to pass if they chose ; and in less than a quarter of an hour, four bees, a butterfly, and some house-flies, had discovered it. Another time he put some into boxes with little holes in the lid, into which pieces of card were fitted, and placed the boxes about two hundred paces from his hives ; in about half an hour the bees found it out, and pushing in the card, got at the honey.

When bees are laden, they always fly in a direct line to the nest, though by what means they are enabled to do this we cannot ascertain. That it is a fact, is strongly proved by the account in the Philosophical Transactions of the manner in which the people of New England discover where the wild bees live in the woods. They set a plate of honey or sugar on the ground, which is soon attacked by the bees : having secured two or three that have filled themselves,

the hunter lets one go, which rising into the air, flies straight to the nest; he then strikes off at right angles with its course a few hundred yards, and letting a second fly, observes its course by his pocket compass, and the point where the two courses intersect is that where the nest is situated.

In Upper Egypt the hives are transported from one place to another, to enable the bees to make a greater provision of honey. Towards the end of October, when the inundations of the Nile have ceased, and the husbandmen can cultivate their land, saintfoin is one of the first things sown; and as Upper Egypt is warmer than the lower, it gets there first into blossom, and the beehives are transported in boats from all parts of Egypt to the upper district, and are there heaped in pyramids upon the boats prepared for them. In this station they remain some days, and when they are supposed to have gathered enough, are removed farther down, and so proceed till the middle of February; when having traversed Egypt, they arrive at the sea, and are delivered to their respective owners.

One of the most important employments of bees is the ventilation of their abode; for the heat would soon rise to too high a temperature

for respiration, and there can be no current of air. But how, you will say, is this done? Just as you would do it yourself—by fanning themselves. By means of the hooks at the edge they unite each pair of wings, and thus make a broader surface, which they vibrate so rapidly as to render the wings almost invisible. This is what produces the constant humming in a hive, and goes on in all seasons.

Now let us consider what I think the most interesting part of their history—their language and tempers. The organ of the language of ants is their antennæ. Huber has proved that it is the same with the bees, and I will tell you in what manner. He wished to know whether, when they had lost their queen (which is known to the whole hive in about an hour), they discovered it by their smell, their touch, or any unknown cause. He first divided a hive by a grate, which kept the two portions two or three lines asunder, so that they could not come at each other, though scent would pass. In the part where there was no queen, the bees were soon in great agitation; and as they did not discover her where she was confined, they soon began to construct royal cells, which quieted them. He next separated them by a partition, through which they could pass their antennæ,

but not their heads. In this case the bees all remained tranquil, and went on with their employments as usual. The means they used to assure themselves that their queen was in their vicinity, and to communicate with her, was to pass their antennæ through the openings of the grate; an infinite number of these organs might be seen at once inquiring in all directions, and the queen was observed answering these anxious questions of her subjects in the most marked manner; for she was fastened by her feet to the grate, crossing her antennæ with those of the inquirers.

That bees remember, is evident from an anecdote related by Huber. One autumn, some honey was placed in a window—the bees attended it in crowds. The honey was taken away, and the window closed with a shutter all the winter: in the spring, when it was opened, the bees returned, though no fresh honey had been placed there.

No one who has been stung can doubt their anger and revenge; indeed they have always been celebrated for it. In Mungo Park's last mission to Africa, he was much annoyed by the attacks of bees. His people, in search of honey, disturbed a large colony of them. The bees

sallied forth by myriads, and attacking men and beasts indiscriminately, put them all to the rout. One horse and six asses were killed or missing in consequence of their attack ; and for half an hour the bees seemed to have completely put an end to their journey. Lesser tells us that in 1525, in a time of war, a mob of peasants attempted to pillage the house of the minister of Elinde, who having in vain employed all his eloquence to dissuade them, ordered his servants to throw his beehives among them ; and it had the desired effect, for they were immediately put to flight.

Great battles sometimes take place between two swarms, when one takes a fancy to a hive pre-occupied by another ; but frequently strangers are not received so inhospitably. Bees from a hive in Mr. Knight's garden visited those of a cottager a hundred yards distant, considerably later than their time of labour ; every bee appearing to be questioned as it arrived. On the tenth morning, however, the intercourse ceased, ending in a furious battle. On another occasion an intimacy took place between two hives of his own, which ended on the fifth day ; but he sometimes observed that these visits ended in the union of two swarms.

You must not think that this apparently prosperous and powerful nation has no enemies; many beasts and birds have a particular taste both for them and their honey. Even frogs and toads are said to kill great numbers, and many fall into the water. Mice, in winter, often commit great ravages. Thorley once lost a stock by mice, which made a nest among the combs. The titmouse, according to the same author, will make a noise at the door of the hive, and when a bee comes out to see what is the matter, will seize and devour it. The swallows will assemble round the hives, and devour them like grains of corn. Bees will bear submersion nine hours, and when taken out of water will revive with proper heat. They are less active in winter, but not absolutely torpid; for the heat in a hive is always great in the coldest weather. I believe I have given you the most interesting particulars relating to these insects, and I hope you will find in their history ample matter for reflection and admiration.—
Adieu.

LETTER VIII.

MY DEAR HARRIET,

I WILL now introduce you to a celebrated, and, in my opinion, interesting race of insects; I mean the ants, which besides being indefatigably industrious, are extremely lively and frolicsome. I will begin with the Termites or white ants, which I think we may consider the nobility of the species. The majority of these animals are natives of tropical countries, though two species are indigenous to Europe, one of which, thought to have been imported, is come as far as Bourdeaux. Their societies consist of five different descriptions of individuals, workers or larvæ, nymphs or pupæ, neuters or soldiers, males and females. 1. The workers are the most numerous and active part of the community, upon whom devolves the office of erecting and repairing the buildings, collecting provision, attending upon the female, conveying the eggs, as soon as laid, to the nurseries, and feeding the young larvæ till they are old enough to take

care of themselves. They are distinguished from the soldiers by their small size and round heads.

2d. The nymphs differ in nothing from the larvæ, except that they have wings folded up in cases.

3d. The neuters are much less numerous than the workers, and much larger in size, and are distinguished by their long and large heads. Their office is that of sentinels and defenders of the nest when it is attacked.

4th and 5th. Males and females, which are the nymphs arrived at perfection: there is only one of each in every separate society, and they are exempted from all participation in the labours and employments of the community. The first establishment of a colony of termites takes place in the following manner.

In the evening, these animals having attained the perfect state, in which they are furnished with two pair of wings, emerge by myriads to seek their fortune. Borne on these ample wings, they fill the air, entering the houses, extinguishing the lights, and even sometimes being driven on board the ships that are near the shore. The next morning they are found covering the surface of the earth and waters, deprived of their wings, and looking like large maggots. In this help-

less state they become the prey of innumerable enemies; and scarcely one pair in many millions escape to found a new colony. The workers, who are continually prowling about in their covered ways, sometimes meet with a pair, and pay them homage, electing them to be the king and queen of a new colony. The workers directly begin to inclose their new rulers in a chamber of clay, suited to their size, but which has a door too small to let them pass through, so that they are kept in complete confinement. When the female begins to lay eggs, the larvæ or workers carry them away to the nurseries, in which when hatched they are provided with food, and receive every necessary attention.

The buildings of the *Termes fatalis*, if considered as in proportion to their size, make the Egyptian pyramids and edifices dwindle into nothing in comparison. The highest pyramid is not more than 600 feet high, which is not more than 120 times the height of the builders, supposing it on an average to be five feet. Whereas the nests of the termites being twelve feet high or more, and themselves only a quarter of an inch long, their building is more than 570 times their own height, which if they were of human stature would be half a mile. These nests are formed en-

tirely of clay, and are generally twelve feet high, and broad in proportion, so that a cluster of them is often taken for an Indian village. The first thing they do is to erect two or three turrets of clay, about a foot high, like sugar-loaves. These rapidly increase in number and height, until at length, being widened at the base, joined at the top with a dome, and surrounded with walls, they appear in the shape of a haycock. When in this state, they remove the inner turrets or scaffoldings, and use the clay for other purposes. They occupy only the lower part of this palace, leaving the top empty for the circulation of air, and defence against the weather. The inhabited part is occupied by the royal chamber; the nurseries for the young ones; storehouses for food; and innumerable galleries, passages, and empty rooms: in the middle is the royal chamber, shaped like an oven, with a very narrow entrance, so that the poor king and queen can never possibly come out. All round it are a great number of arched rooms of different sizes, either opening into each other or communicating by passages, and intended for the soldiers and attendants in waiting on their royal mistress. Next are the nurseries and magazines. The former are occupied by the eggs and young ones,

and as they increase in number, are taken down and rebuilt. They differ from all the rest in being made of particles of wood, apparently joined together with gums. Intermixed with these are the magazines formed of clay, and containing particles of wood, gums, and the inspissated juices of plants. These apartments, separated by small empty chambers and galleries, are continued on all sides to the outer wall of the building, to about two-thirds of its height; leaving, however, an open area in the middle, like the nave of a cathedral, supported by three or four large Gothic arches, which in the middle are sometimes two and three feet high, but on each side are diminished like aisles of arches in perspective. The floor is so contrived as to let any water that may happen to get in run off into the subterranean passages, which are of an astonishing size; some being a foot in diameter, and quite round and smooth: they were the quarries from which they procured materials for building, and serve afterwards as the outlets of their fortress. As they find great difficulty in ascending a perpendicular, they make in the interior upright part of the building a flat pathway, which winds gradually up, like a road cut in the side of a mountain. Who will say

that we could learn nothing from insects? They, taught by unerring wisdom, have used from time immemorial the boasted discoveries of man; and, perhaps, if rightly observed, might teach us many more. They have, however, a contrivance still more extraordinary; they make a bridge of one vast arch, from the floor to the upper apartments at the side, which serves as a flight of stairs, and shortens the distance extremely. Mr. Smeathman measured one of these bridges, which was half an inch broad, a quarter of an inch thick, and ten inches long. It was strengthened by a small arch at the bottom, and had a groove along the upper surface, probably that they might not fall over. It is not the least surprising circumstance that, as Mr. Smeathman saw every reason for believing, the termites *project*, that is, build their arches, instead of excavating them.

When any one is bold enough to attack the nest and make a breach in the walls, the labourers, who are incapable of fighting, retire within and the soldiers come out. One first appears to reconnoitre, then two or three more scramble after him, and presently a large body of them rush forth as fast as they can, with indescribable rage and fury. In their haste they frequently miss

their hold, and tumble down; but they soon recover themselves, and bite every thing they run against, when it is prudent to keep out of their way, for they make their fanged jaws meet at the very first stroke, and will not let go though pulled limb from limb.

If on the first attack you give them no further interruption, in less than half an hour they return into the nest, and the labourers hasten in all directions towards the breach, every one carrying in his mouth a lump of mortar, half as big as his body, which he sticks on the breach; and this is done with so much regularity and despatch, that although thousands or millions are employed, they never appear to interrupt each other.

While the labourers are thus employed, almost all the soldiers retire, except here and there one, who saunters about among the workers, but never assists in the work. One in particular places himself close to the wall which they are building, and turning himself leisurely on all sides, as if to survey the proceedings, appears to act as an overseer of the works.

Every now and then, at the interval of a minute or two, by lifting up his head and striking with his forceps upon the wall of the nest, he makes a particular noise, which is answered by a loud

hiss from all the labourers, and appears to be a signal for despatch ; for every time it is heard, they are seen to redouble their pace with increased diligence. If you renew the attack, the same scene will be repeated ; the labourers will disappear, and the soldiers rush forth as before ; and when all is quiet, the workers resume their task, but never attempt to fight. The termites, however, do not always go under covered-ways. There is a larger species, which Mr. Smeathman calls the marching termes. He was once passing through a thick forest, when, on a sudden, a loud hiss like that of serpents struck him with alarm : the next step produced a repetition of the sound, which he then discovered to be that of the white ants ; yet he was surprised at seeing none of their hills or covered-ways. Following the noise, to his great astonishment and delight, he saw an army of those creatures emerging from a hole in the ground ; their number was prodigious, and they marched with the utmost celerity. When they had proceeded about a yard, they divided into two columns, chiefly composed of labourers about fifteen abreast, following each other in close order, and going straight forward. Here and there was seen a soldier, carrying his vast head with apparent difficulty, and looking like

an ox in a flock of sheep, who marched on in the same manner. At the distance of a foot or two from the columns, many other soldiers were to be seen standing still or pacing about, as if upon the look out, lest some enemy should suddenly surprise their unwarlike comrades; other soldiers (which was the most extraordinary part of the scene) having mounted some plants, and placed themselves on the points of their leaves, elevated from ten to fifteen inches from the ground, hung over the army marching below, and by striking their forceps upon the leaf, produced at intervals the noise before-mentioned. To this signal the whole army returned a hiss, and obeyed it by increasing their pace. The soldiers at these signal stations sat quite still during the intervals of silence, except now and then making a slight turn of the head, and seemed as solicitous to keep their posts as regular sentinels. The two columns of this army united, after continuing separate for twelve or fifteen paces, having in no part been above three yards asunder, and then descended into the earth by two or three holes. Mr. Smeathman continued watching them for above an hour, during which time their numbers appeared neither to increase nor diminish. The soldiers, however, who quitted

the line of march, and acted as sentinels, became much more numerous before he quitted the spot. The larvæ and neuters of this species are furnished with eyes.

I shall now give you some account of my little favourites, the English ants, of which, according to Gould, there are five species: viz. 1st, the hill ant (*formica rufa*); 2. the jet ant (*formica fuliginosa*); 3d, the red ant (*myrmica rubra*), which is the only species armed with a sting, whereas the others make a wound with their forceps, and inject the poison into it; 4th, the common yellow ant (*formica flava*); and 5th, the small black ant (*formica fusca*). The societies of ants differ from those of termites, in having inactive larvæ and pupæ, the neuters being at the same time soldiers and labourers. The foundation of their colonies differs from that of the termites in this respect, that the female, after losing her wings, does all the work usually performed by the neuters, and is soon assisted by her infant progeny. However, the females are not always at liberty to leave the nest they were born in, and the workers pull off their wings and forcibly detain them till they are reconciled to their fate: they then go where they please, attended by a single ant. When the female has laid her eggs, the workers begin

to pay her homage much the same as the bees render to their queen.

All press round her, offer her food, and conduct her through the formicary, sometimes even carrying her on their jaws. When she is set down, others surround and caress her, one after another, tapping her on the head with their antennæ. "In whatever apartment," says Gould, "a queen condescends to be present, she commands obedience and respect. An universal gladness spreads itself through the whole cell, which is expressed by particular acts of joy and exultation. They have a particular way of skipping, leaping, and standing upon their hind legs, and prancing with the others. These frolics they make use of both to congratulate each other when they meet, and to show their regard for their queen; some of them gently walk over her, others dance round her; she is generally encircled with a cluster of attendants, who if you separate them from her, soon collect themselves in a body, and inclose her in the midst." I fear, my dear Harriet, that all which I shall relate to you concerning these insects will appear almost incredible, but there is no doubt of the veracity of the authorities from which the account is derived; and if you ask how any body could see into an ant-hill, I

must tell you that **M. P. Huber** invented a kind of ant-hive, by which he could watch their proceedings; but I must defer any farther account to my next letter. Adieu!

LETTER IX.

MY DEAR HARRIET,

LET us now consider a little the language of our formic friends, though I am sorry to say I cannot teach it to you grammatically. That they *have* a language is very evident, though they have no voice, *in common with all other insects*. The following facts prove their powers of communication, though the most superficial observer might judge for himself. If those on the surface are alarmed, it is astonishing how soon the alarm spreads through the whole nest. It creates the greatest bustle, and they carry, with all possible despatch, their treasures, the larvæ, and pupæ or eggs, as they are commonly called, down to the lowest apartments.

A species which is found on the continent inhabits hollow trees. M. Huber observed that when he disturbed those farthest from the rest, they ran towards them, and striking their head against them, communicated the cause of their fear or anger; that these conveyed the intelligence to

others, till the whole colony was in a ferment. The legs of one of M. Huber's formicaries were plunged into pans of water to prevent the escape of the ants; this proved a source of great enjoyment to these little beings, for they are a thirsty race, and lap water like dogs. One day when he observed many of them drinking very merrily, he was so cruel as to disturb them, which sent most of the ants to the nest, but some, more thirsty than the rest, continued their potations. Upon this, one who had retreated returned to inform his thoughtless companions of their danger: one he pushed with his jaws, another he struck on the body, and so obliged three of them to leave off carousing and return; but the fourth, more resolute to drink it out, was not to be discomfited, and paid not the least regard to the kind blows with which his compeer repeatedly belaboured him: at length, determined to have his way, he seized him by one of his hind legs, and gave him a violent pull: upon this, leaving his liquor, the loiterer turned round, and opening his threatening jaws, with every sign of anger, went very coolly to drinking again; but his monitor, without further ceremony, rushing before him, seized him by the jaws, and at last dragged him off in triumph to the nest.

Some, which engage in military expeditions, previously send out spies to collect information, and when they return, the army proceeds accordingly to the quarter whence they arrived. Upon the march, communications are continually making between the van and the rear, and when arrived at the camp of the enemy, and the battle is begun, couriers are despatched to the nest for reinforcements, if necessary. What more can man do in his expeditions? It is well known that ants give each other notice of a store of provision. Bradley says that a nest of ants, in a nobleman's garden, discovered a closet in the house in which preserves were kept; some in their rambles must have made the discovery and imparted it to their comrades, for they constantly visited it till the nest was destroyed. I will also give you another authority, which I hope you will consider very respectable, I mean my own. I have often watched the track of the ants across the path of the garden, and sometimes when an ant had proceeded at the usual pace, half across, another would come running after him, and touching him with his antennæ, or horns, they would both run back again as fast as their little legs would carry them, leaving me in the greatest curiosity to know what they said. I never saw one meet

another without touching his antennæ, which as they make no significant sounds, like bees, must be their organ of speech, supplying the place both of voice and words. The signal for marching is made by the military ants touching the trunk with their antennæ and forehead. They also express in different ways their aversions and affections, and though we cannot easily ascertain whether they feel individual attachment, they certainly work for the public good, and any distress falling on a member of their community generally excites their sympathy. M. Latreille once cut off the antennæ of an ant, and its companions, evidently pitying its sufferings, anointed the wounded part with a drop of transparent fluid from their mouth; and whoever observes them will be pleased to see how they assist each other in difficulties. They even recognise each other after absence, and evince a striking satisfaction. M. Huber witnessed the gesticulations of some ants, originally belonging to the same nest, who met after four months' separation, and though this was equal to a quarter of their life as perfect insects, yet they mutually recognised each other, saluted with their antennæ, and united once more to form one family. They are also ever ready to promote each other's wel-

fare, and share any good thing they may meet with. Those which go abroad feed those who remain in the nest, and if they discover any stock of food, they inform the whole community. M. Huber having produced heat by means of a flambeau, in a certain part of an artificial formicary, the ants that happened to be in that quarter, after enjoying it for a time, hastened to convey the welcome intelligence to their compatriots, whom they even carried suspended on their jaws to the spot, till hundreds might be seen thus laden with their friends.

What a striking example of disinterestedness do these insects, which have the general stigma of selfishness so unjustly attached to them, present, and how clearly does this injustice show us the folly of judging on superficial and imperfect grounds; let us not therefore condemn hastily any being that we fancy horrible and disgusting, but which on minute investigation will generally appear more really beautiful than those preferred by our comparatively unrefined senses. But to return to the ants. They are susceptible of anger as well as love, even to fierceness. Providence has furnished them with formidable weapons. Two strong mandibles arm their mouth, with which

they hold so fast, that they will sooner be torn limb from limb than let go their hold ; and after their battles the head of a conquered enemy may often be seen hanging on the antennæ or legs of the victor, which he is obliged to wear, however troublesome, to the day of his death. Their poison bag is furnished with a powerful and venomous acid, which is celebrated for its efficacy, and exhales a strong sulphureous odour. Their courage is unconquerable, and often rises into extreme fury. If you point your finger at a hill ant, instead of running away, it faces about, and that it may make the most of itself, stiffens its legs to raise its body as high as possible, and thus prepares to repel your attack. If you put your finger nearer, it opens its jaws to bite. Does not this little creature show more courage than the greatest hero of the human race? Even Achilles himself would run away from a finger as much larger than himself, in proportion, as ours is larger than the ant. You will naturally suppose that so courageous a people frequently make war on each other, which is the case, and I might here invoke the muse to sing their battles, with as much reason as the poets who celebrate the similar contests of man. They fight for territory, for the droves of aphides, equally valuable with the flocks and

herds that cover our plains, and the body of a fly or beetle, or a cargo of straws, and bits of stick, are as important to them as a fleet to our seamen. These wars are usually between those of a different species, but sometimes between those of the same, when so near as to incommode each other : among the red ants, combats sometimes take place in the same nest. In these battles the neuters or workers are the only warriors, the males and females taking the wiser, if not more honourable part, of flight.

The wars of the red ant appear to be only between a small number of the citizens, and the object of the popular tumult seems to be to get rid of some useless member of the community, or perhaps some criminal who will not work. Gould says that many of them may be seen surrounding one of their own species, and pulling it to pieces. This unfortunate ant is generally feeble and languid ; but if from illness, it does not say much for their humanity. He once saw one of these ants dragged out of the nest without its head, but still alive and able to crawl. This poor ant might be fancied a criminal condemned by a court of justice to suffer the sentence of the law. Mouffet bears testimony to a similar fact.

The wars of the ants, not of the same species, take place usually among those which differ in size; but the large ones are frequently outnumbered and defeated by their little adversaries. Sometimes, however, after suffering a signal defeat, the smaller species are obliged to shift their quarters and to seek another establishment. In order to cover their march, many small bodies are posted at a little distance from the rest. As soon as the large ants approach the camp, the foremost sentinels fly at them with the greatest fury, a violent struggle ensues, multitudes of their friends come to their assistance, and the giant is either slain or led captive. The species which M. Huber observed to fight in this way were *formica herculanea*, and *formica sanguinea*, neither of which have been discovered in Britain. If you would see war, in all its forms, you must behold the combats of the hill ant. There you will see populous and rival cities, like Rome and Carthage, as if they had vowed each other's destruction, pouring forth their myriads, by various roads, to decide their fate by arms. Figure to yourself two of these cities, equal in size and population, and situated about a hundred paces from each other; observe their countless numbers, equal to the population of two mighty em-

pires. The whole space which separates them, for the breadth of twenty-four inches, appears alive with prodigious crowds. The armies meet midway between their habitations, and then join battle. Thousands of champions mounted on more elevated spots engage in single combat, and seize each other with their powerful jaws; a still greater number are engaged on both sides in taking prisoners, which make vain efforts to escape, conscious of the cruel fate which awaits them. The spot where the battle most rages is about two or three square feet in dimensions; a penetrating odour exhales on all sides,—numbers of ants are here lying dead, covered with venom,—others composing groups and chains are hooked together by the legs or jaws, and drag each other alternately in contrary directions till the strongest party prevails, and the single combats recommence. At the approach of night each party gradually retreats to its own city, but before the following dawn the combat is renewed with redoubled fury, and occupies a larger space, inspiring you to exclaim with the poet's martial fervour,

“The combat deepens—on, ye brave!”

These daily fights continue till violent rains separating them, they forget their quarrel, and

peace is restored. It is very astonishing that, though they are all of the same make, colour, and scent, every one seemed to know those of his own party, and if one was attacked by mistake it was immediately discovered by the assailant, and caresses succeeded to blows. The presence of M. Huber, who was a witness of one of these battles, did not in the least disturb them. Though all was fury on the field of battle, on the other side were ants peaceably going on their usual avocations, and the whole formicary seemed tranquil and orderly, except where they were marching to recruit the army, or bring home prisoners. I know not whether you will feel much disposed to believe what I am now going to relate to you, but it rests on the respectable authority of M. Huber, who discovered it. What do you think of ants going out on expeditions to procure slaves for their domestic purposes? and that these ants are red, while the slaves are black! M. Huber appeals to all who doubt the fact to observe it for themselves; but as we cannot do so in this country we must trust to his testimony, which, let us remark, was given in a country where it *might* be observed. There are two species of ants which engage in these expeditions, *formica rufescens* and *formica sanguinea*; but they

do not, like the African kings, make slaves of the older ones ; their object being to carry off the infants of the colony, the larvæ and pupæ, which they educate in their own nests till they arrive at their perfect state, when they undertake all the business of the society. The rufescent ants do not go on these excursions, which last about ten weeks, till the males are ready to emerge into the perfect state ; and it is very remarkable, that if any individuals attempt to stray abroad earlier, they are detained by their slaves, who will not suffer them to proceed ; a wonderful provision of the Creator to prevent the black colonies from being pillaged when they contain only male and female brood, which would be their total destruction, without being any benefit to their assailants, to whom workers alone are useful. Their time of sallying forth is from two to five o'clock, if the weather is fine. Previously to marching they send out scouts, and proceed to the quarter from whence they come. The advanced guard usually consists of eight or ten ants ; but no sooner do these get beyond the rest, than they move back, wheeling round in a semicircle, and mixing with the main body, while others succeed to their station. They have "*no captain, overseer, or ruler,*" as Solomon observes,

their army being composed entirely of neuters. They do not confine themselves to the negro ants; for, if nearer, they sometimes attack the *mining* ants, which are much more courageous, and therefore they move with closer order and rapidity. The miners dart upon them, fight foot to foot, and defend their progeny with unexampled courage. During these combats the pillaged ant-hill presents in miniature, the spectacle of a besieged city; hundreds of its inhabitants may be seen making their escape, and carrying off their young brood, and the newly excluded females, to a place of safety; but when the danger is over they bring them back, and barricade their city, placing a strong guard at the entrance.—*Formica sanguinea* is another of the slave-making ants. On the 15th of July, at ten in the morning, Huber observed a small band of these ants sallying forth from their nest and marching rapidly to a neighbouring nest of negroes; around which it dispersed. The inhabitants rushing out, attacked and took several prisoners; those that escaped stopped, appearing to wait for succours; small brigades kept frequently arriving, which emboldened them to approach nearer to the city they blockaded; upon this their anxiety to send home messengers seemed to increase; these spreading a general

alarm, a large reinforcement immediately set out to join the besieging army; yet even then they did not begin the battle. Almost all the negroes coming out of their fortress, formed themselves in a body of about two feet square in front of it, and there expected the enemy. Frequent skirmishes were the prelude to the main conflict, which was begun by the negroes. Long before success appeared dubious, they carried off their pupæ and heaped them up at the entrance to their nest, on the side opposite to the enemy. The young females also fled to the same quarter. The sanguine ants at length rushed upon the negroes, and attacking them on all sides, after a stout resistance, the latter renouncing all defence, endeavoured to make off to a distance with the pupæ they had heaped up: the assailants pursued and endeavoured to gain the prize. Many also entered the nest and carried off the young brood left behind. A garrison being left in the captured city, on the following morning the business of transporting the brood is renewed. It often happens that the invaders take up their habitation in their new conquest. Because these negro ants are made slaves, you must not imagine they are treated with rigour or unkindness. They have only the same labours they must have

performed in their native nest, except, indeed, feeding their masters and carrying them about. Alas! that laziness should infect even the most industrious of animals! for they do not join in the labour, or even direct their slaves, and when not on the field of battle are quite helpless, being even unwilling to feed themselves. Indeed they are so dependent on the slaves, that, by a natural consequence, the latter seem to exercise a kind of authority over them. They will not suffer them, for instance, to go from the nest alone, and if they return to the nest without booty, show their displeasure by attacking them, and when they attempt to enter, dragging them out; so you see that they pay dearly for their laziness, as all must who depend on others for what they ought to do themselves. Adieu.

LETTER X.

WHAT I have next to relate, my dear Harriet, will be still more difficult to believe than the foregoing. What do you think of ants having their milch cattle? The evidence for it is abundant and satisfactory. The loves of the ants and the aphides (the small insects which swarm on the stalks of roses, &c. &c.) have long been celebrated, and at the proper season you may observe them busy in obtaining their saccharine fluid, which we may call milk.

This fluid, which is scarcely inferior to honey in sweetness (and is, in fact, called *honey-dew* when found on leaves), issues in limpid drops from the abdomen of the insect by these orifices. The ants are always at hand to watch for these drops, which they seize and suck down; but if they choose they can make them yield it at their pleasure, or rather *milk* them. They use their antennæ for fingers, with which they pat the aphids briskly till it yields its milk. But the most singular part of this history is, that the ants

make a property of these cows, which they fight for, and endeavour to keep to themselves. If strangers attempt to share their treasure, they drive them away with as much anger as a farmer would show to a thief he found milking his cows. Sometimes to rescue them they take them in their mouths, and even, if the branch is conveniently situated, inclose it in a tube of earth or other materials, and thus confine them in a kind of paddock near the nest!

The greatest cow-keeper of all is the yellow ant, which is met with in our pastures. This species, which is not fond of roaming, and likes to have every thing within reach, usually collects in its nest a large herd of a kind of aphid that lives on the roots of grass, and thus, without going out, has always a copious supply of food. They take as much care of them as of their own offspring, and attend the eggs particularly, moistening them with their tongues, and giving them the advantage of the sun. They are equally careful after they are hatched, fighting fiercely for them if attacked; but we shall not be surprised at this, when we consider that they produce almost their only food, and thus their wealth and prosperity depend on the number of their cattle.

When some species of ants (chiefly the great hill-ant) find their habitation incommodious, they often emigrate, and the first step is to raise recruits; and this is done in a manner very like that pursued by our own army. They eagerly accost their fellow citizens, caress them with their antennæ, and evidently propose the journey to them. If they seem disposed to go, the recruiting officer carries off his recruit, who, hanging by his mandibles, is coiled up spirally under his neck. Sometimes, however, they take them by surprise, and drag them away, as in our impress service for the navy. When arrived at the right place, the recruit is dropped and becomes a recruiter in his turn; and thus they proceed till the city is established: the old nest goes on as usual. They work in the night as well as the day, though not in such great numbers, as they are fond of warmth. They make good roads and paths, in which they always travel. Huber says that the roads of the hill-ants are sometimes a hundred feet in length, and several inches wide, and that they are hollowed out by their labour.

The perseverance of ants on one occasion led to very important results, which affected a large portion of the world; for the celebrated con-

queror Timour being once forced to take shelter from his enemies in a ruined building, where he sat alone many hours, desirous of diverting his mind from his hopeless condition, he fixed his observation upon an ant that was carrying a grain of corn (probably a pupa) larger than itself up a high wall. Sixty-nine times the grain fell to the ground, but the seventieth time the ant reached the top of the wall. "This sight (said Timour) gave me courage at the moment, and I have never forgotten the lesson it conveyed."

You must not suppose that the ants have all work and no play. They find time for their sports and games, which have been described by Gould and Bonnet; but Huber gives the most circumstantial account of them. He once approached one of the nests of the hill-ants, exposed to the sun and sheltered from the north; here the ants were basking together in great numbers, and gamboling about. None were working, so that it seemed a general holiday: let us imagine it a festival given on some great occasion. He saw them approach, moving their antennæ very quickly, and with their fore feet pat the cheeks of other ants; after, they reared up and seemed to wrestle, and seized each other in different ways; then let go to renew the at-

tack; then turned each other over, and lifted each other by turns; then left those, and ran after others. The combat did not terminate till the least animated having thrown his antagonist, escaped into some gallery. Well, my dear Harriet, what do you think of this clever little people? Does it not occur to you, that if we imitated more closely their various good qualities, we should be much better than we are? In doing this we should but follow the wisdom of the great Creator, who has given them these extraordinary instincts, and has bestowed on us the higher boon of being able to draw rational conclusions from them, which will, if we observe rightly, lead to the same end. Adieu.

LETTER XI.

MY DEAR FRIEND,

THERE is a tribe of insects more numerous and more varied than almost any other, and which furnishes a great branch of their natural history—I mean the tribe of flies. The number of species greatly exceeds that of butterflies, but in general they are very much smaller; there are, however, some which greatly surpass them in size; dragon-flies, for instance, whose bodies are longer than those of the largest butterflies. Grasshoppers belong to the class of flies, and some are of considerable size; but the greatest part are comparatively very small, and some so diminutive, that the different species cannot be distinguished from each other.

The principal distinction of flies from other winged insects is the transparency of their wings, which are neither powdered like the butterfly's, nor enclosed in sheath-cases like the beetle's. There are two general classes, according to Reaumur, those with two wings, and those with four. The two-winged flies have, in place of the under

wings, poisers and sometimes winglets. The poisers are little membranaceous threads, placed one under the origin of each wing, near a spiracle or breathing hole, and terminated by an oval, round, or triangular button, which seems capable of dilatation and contraction. The winglets are of rigid membrane, and fringed, and generally consist of two concavo-convex pieces situated between the wing and the poisers, which, when the insect reposes, fold over each other like the valves of a bivalve shell; but when it flies they are extended. If either of the winglets or poisers are cut off, the insect flies unsteadily, and leans to one side. The buzzing or humming of a fly is produced by the vibration of the root of the wings, and in most instances by the winglets and poisers. Though in their general appearance flies greatly resemble each other, yet in the form of the head and organs of feeding there is a material difference. Some have a trunk without any teeth; some have a mouth without either trunk or teeth; others have a mouth furnished with teeth, and others have both trunk and teeth. To give you a few examples. All the bee species have a trunk and two teeth above it: all the tribe of wasps have a mouth and two teeth inside. The plant-lice or aphides, which,

whether winged or not, are in reality flies, have trunks and no teeth. Reaumur also places the grasshoppers among the flies. There is another species, which however is scarce, that of flies which have a long pointed head like a bird's beak, at the end of which are the instruments with which it feeds. A very pretty fly which hovers round flowers is an example of it, and has its long head split at the end, which opens like a beak.

An instance of the importance of the difference in the form of the head, I can give you in those flies which sometimes in summer bite so sharply even through a covering, and instantly draw blood. To a superficial or even attentive observer, they exactly resemble the common house-flies, which often fall a sacrifice to the unfortunate likeness; yet they are not even of the same genus, the culprit being of the genus *stomoxys*, armed with a horny sharp-pointed weapon, and the innocent victim of the genus *musca*, having only a soft blunt organ for suction.

Another important difference is between the weapons they carry on the tail. Those which are armed with a sting are but too well known; but others are formed in a manner no less admirable and more harmless. Many females of the fly

kind have a long instrument for the purpose of piercing a hole in which to deposit their eggs in safety, which is called an ovipositor. Many of the ichneumon kind which deposit their eggs in living animals have this long tail, which is a most admirable instrument. The grasshoppers, in particular, have a large and strong ovipositor, but it is partly concealed by the body. In *locusta viridissima*, the green English locust, which is frequently found in grass, it is very conspicuous. The saw-flies have for the same purpose a most admirable and effective saw, which is contained in their bodies; but if I were to enumerate all the various and beautiful instances of exquisite contrivance observable even in this tribe, it would go far beyond the limits of a letter; I shall therefore mention what occurs to me, in a desultory manner.

It must, I think, have often surprised you to see flies walking upon glass, and the ceiling and walls. It was formerly supposed to be performed by means of the hooks with which their feet were furnished, and to the smokiness and ruggedness of the glass; but as they walk equally well on it when just cleaned, and on the most polished mirror, we must find another reason. It is ascertained that they are furnished with

suckers which support them by the pressure of the atmosphere. These suckers consist of a membrane capable of extension and contraction; they are concavo-convex, with scalloped edges, the concave surface being downy, and the convex granulated. When in action they are separated from each other, and the membrane expanded so as to increase the surface: by applying this closely to the glass, the air is sufficiently expelled to produce the pressure necessary to keep the animal from falling. When the suckers are disengaged, they are brought together again so as to be confined within the space between the two claws: this may be seen by watching the movements of a fly, inside a glass tumbler, with a common microscope. If you wet a piece of leather, and apply it closely to any thing, you will see an example of this suction in the difficulty you will find in detaching it. You must have often observed that in the autumn the flies begin to move more slowly, and appear sometimes to stick to the glass; Mr. White remarks on this, that when their strength diminishes, the atmospheric pressure proves too strong for them to overcome, and they appear to labour along. They are besides furnished with a cushion of bristles or hooks, and claws.

There are fourteen thousand hemispheres or eyes distinguishable in the large eyes of the drone-fly, and each of these is a perfect eye, being furnished with a *cornea*, a transparent humour, and a *retina*. The most remarkable of insects for its eyes, is the libella, or dragon-fly: Leeuwenh ock reckons in both twenty-five thousand and eighty-eight lenses, placed in an hexangular position. He also numbered six thousand two hundred and thirty-six in those of the silk-worm in the imago state, and eight thousand in the common fly. These large eyes are all immoveable, and so placed that the insect can see on all sides without turning. Reaumur asserts, that many kinds have besides three small eyes on the back of the head.

Flies, in common with other insects, breathe by means of spiracles or breathing holes. All, whether two or four-winged, which have an individual corslet or thorax to which the six legs are fastened, have four of these breathing-holes, two on each side the corslet. They have also others on the wings or segments of the body, but less considerable. They are placed lengthways on the body, being oblong, with raised edges, and generally of a different colour from the body; they are most easily discovered in the

large dragon-flies. If these breathing-holes or mouths are stopped by plunging the insect in oil, or any other thick substance, suffocation is the consequence; indeed they may be truly called aërial beings, for air is the only circulating medium through the veins and branches of their wings, consequently their activity depends on the state of the atmosphere.

The gnats are but too exquisitely formed for our repose. The trunk, if we may so call the complex weapon in its mouth, is highly deserving of a particular description, though I do not know that the beauty of it can console us for the pain it causes. It consists of an open cylindrical sheath, containing five pieces, which are like pikes and saws. The sheath is not slit all the way down, and we shall see the reason. The point, which pierces the skin is composed of several others, and comes out of the round end of the sheath; and as this sting, if we may so call it, must entirely enter the flesh to draw blood, the sheath, which is necessarily strong and stiff, and cannot pierce also, bends away the sting, which, except at the point, comes out of the slit part, and the sheath makes an angle underneath, and is drawn up towards the head. I do not know whether you can understand this description,

which Reaumur has illustrated with engravings, but I fear I cannot make it clearer. The beautiful feathery antennæ of many kinds are visible even to the naked eye. The *tipulidæ*, which strongly resemble the gnat, are, however, essentially different in not having any trunk or offensive weapon; they have only a mouth without even any teeth. They are a very numerous tribe, and are probably generally mistaken for gnats. They are for the greatest part born under ground, while the maggot of the gnat is always aquatic. You must often observe, even in winter, clouds of little flies at different times of the day, which are constantly rising and falling in a straight line; and these are commonly of this species, and quite harmless. The largest *tipula* appears to be mounted on stilts, having legs of almost disproportionate length, which, however, are well adapted for walking in grass.

The saw-flies are four-winged, and have two saws indented like ours, but much more curiously; for the teeth themselves are indented again, and the fly in using them makes a double action, by drawing one back while she pushes the other forward. The use of them is to make a hole in the branches of different trees for the reception of the eggs.

The grasshopper tribes, or *gryllidæ*, and the Cicada (*tettigonia*), are chiefly remarkable for the noise or chirping they make; which however is confined to the males, as the females are quite mute. The common grasshopper produces his morning and evening song by applying his posterior shank to the thigh, and rubbing it briskly against the elytrum, or wing-case; this it does alternately with the right and left legs: they have also a tympanum or drum. De Geer thus describes it:

On each side of the first segment of the abdomen, immediately above the origin of the hind legs, there is a considerable and deep aperture of rather an oval form, which is partly closed by an irregular flat plate, or operculum, of a hard substance, but covered with a wrinkled flexible membrane. The opening left by this operculum is crescent-shaped, and at the bottom of the cavity is a white skin tightly stretched over, and shining like a little mirror. On that side of the aperture, which is towards the head, there is a little oval hole into which the point of a pin may be introduced without resistance. When the pellicle is removed, a large cavity appears. This description, which is that of the migratory locust (*gryllus migratorius*), answers very well to the tympanum of the common grasshoppers

The vibrations caused by the friction of the thighs and elytra striking upon this drum, are reverberated by it. The crickets make their intolerable chirping by rubbing the bases of their elytra against each other. I must describe their form to give you some idea how they do it. The elytra of both sexes are divided longitudinally into two portions; a vertical or lateral one which covers the sides, and a horizontal or dorsal one which covers the back.

In the female both these portions resemble each other in their nervures or veins, which running obliquely in two directions, by their intersection, form numerous small meshes of a lozenge shape: the elytra of these have no elevation at the base. In the males the vertical portion does not materially differ from that of the females; but in the horizontal, the base of each elytrum is elevated so as to form a cavity underneath. The nervures also, which are stronger and more prominent, run here and there into different kinds of forms; particularly near the end of the wing you may observe a space nearly circular, with the vein running round it. The friction of the nervures of the upper or convex surface of the base of the left-hand elytrum, which is undermost, against those of

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The first step in the process of determining the vertical position of the center of gravity is to determine the horizontal distance from the base of the object to the center of gravity. This can be done by measuring the horizontal distance from the base of the object to the point where the center of gravity is located. Once this distance has been determined, it can be used to calculate the vertical position of the center of gravity.

...the ... of ...

1. *Journal of the American Medical Association*, 1997; 277: 103-107.
 2. *Journal of the American Medical Association*, 1997; 277: 108-112.



Fennel's

1. *Locusta viridissimus* — Green English Locust. Female.

2. *Curculio imperialis* — Diamond Beetle. 3. *Scarabaeus auratus* — Green Rose Beetle.

4. *Blatta gigantea* — Giant Cockroach.

the lower or concave surface of the base of the right hand, which is uppermost, will communicate vibrations to the areas of membrane more or less intense in proportion to the rapidity of friction. Nothing can be more annoying than the continual chirping of the house-cricket, which, however, can be silenced in general, I believe, by a still greater noise. Ledelius relates, that a woman who had tried in vain every method to banish them from her house, at last got rid of them by the noise of drums and trumpets which she had procured to entertain her guests at a wedding. They instantly forsook the house, and did not return.

In *locusta viridissima*, our green English locust, which is very common, there is in that part of the right elytrum which is folded over the trunk, a round plate made of very fine transparent membrane, resembling a little mirror or piece of talc, of the tension of a drum. This membrane is surrounded with a very strong and prominent nervure, and is concealed under the fold of the left elytrum, which has also several prominent nervures answering to the margin of this membrane. De Geer further remarks, that there is every reason to believe that the brisk movement with which the grasshopper rubs its

nervures against each other, produces a vibration in the membrane, augmenting the sound. The males in question sing continually in the hedges and trees during the months of July and August, especially towards sunset and part of the night; but when any one approaches, they immediately stop. Some of the tribe of cicadæ are far more noisy than any of the preceding, and the Brazilian cicada is said to be heard at the distance of a mile, which is as if a man of ordinary stature could be heard all over the country. To produce this amazing sound they have a very complex and wonderful organ. Under the body of the male is a pair of large plates of an irregular form—in some semi-oval, in others triangular, in others again a segment of a circle of greater or less diameter—covering the anterior part of the abdomen, and fixed to the trunk between that and the hind legs: these are the drum-covers or opercula, from beneath which the sound issues. At the base of the posterior legs, just above each operculum, there is a small pointed triangular process, the object of which, as Reaumur supposes, is to prevent them from being too much elevated. When an operculum is removed, beneath it is perceived, on the exterior side, a hollow cavity, with a mouth somewhat linear, which

seems to open into the interior of the abdomen: next to this, on the inner side, is another large cavity of an irregular shape, the bottom of which is divided into three portions; of these the posterior is lined obliquely with a beautiful membrane, which is very tense—in some species semi-opaque, and in others transparent—reflecting all the colours of the rainbow. This mirror is not the real organ of sound, but is supposed to modulate it. The middle portion is occupied by a plate of a horny substance placed horizontally, and forming the bottom of the cavity: on its inner side this plate terminates in a carina or elevated ridge, common to both drums. Between the plate and the after-breast (*postpectus*) another membrane, folded transversely, fills an oblique, oblong, or semi-lunar cavity. It is sometimes seen in tension, and probably the insect can stretch or relax it at pleasure; but the organ which produces the sound remains yet to be described, and can only be discovered by dissection. A portion of the first and second segments being removed from that side of the back of the abdomen which answers to the drums, two bundles of muscles, meeting each other in an acute angle, attached to a place opposite the point of the mucro of the first ventral segment

of the abdomen, will appear. These bundles consist of a prodigious number of muscular fibres applied to each other, but easily separated. Whilst Reaumur was examining one of them, pulling it from its place with a pin, he let it go again, and immediately the usual sound was emitted, though the animal had been long dead.

On each side of the drum-cavities, when the opercula are removed, another cavity of a roundish shape, opening into the interior of the abdomen, is observable: in this is the true drum. If, in this last cavity, the lateral part of the first dorsal segment of the abdomen is removed, a semi-opaque and nearly semicircular concavo-convex membrane, with transverse folds, is discovered. Each bundle of muscles is terminated by a tendinous plate nearly circular, from which issue several little tendons that, forming a thread, pass through an aperture in the horny piece that supports the drum, and are attached to its under or concave surface. Thus the muscles being alternately relaxed and contracted, will, by their play, draw in and let out the drum: so that its convex surface being thus rendered concave when pulled in, when let out, a sound will be produced by the effort to recover its convexity; which sound striking upon the mirror and other

membranes, will be modulated and augmented by them. What can be more complex and admirable than all this apparatus? We know not how many wonders are contained in the apparently insignificant beings we tread under foot every day, without even seeing them.

The common dragon-fly, or *Libellula varia*, is a very beautiful insect, and is generally found near water; it has a very large head, with conspicuous eyes, large transparent wings, with black veins, and a very long body richly variegated with blue and black. It is of a very rapacious nature, and preys on the smaller insects, but is perfectly destitute of a sting. It proceeds from a larva which inhabits the water, and is of a very peculiar and disagreeable form. During this state, which lasts two years, it is as rapacious as when perfect. When the period of its change is arrived, it ascends the stem of some water-plant, and by a few efforts breaks open the skin of the back, when the inclosed dragon-fly gradually emerges; its wings, which are at first very short, tender, and contracted, expanding by degrees to their full size. In the space of about half an hour the change is complete; and the same animal which before that time would have been killed by any long exposure to the air, would

now be as effectually destroyed by submersion under water. I have told you but a small part of the wonders and perfections of this beautiful tribe of insects, which even a casual observer must be struck with, and which every summer presents in almost inconceivable variety. While we admire their exquisite symmetry and brilliant tints, let us, my dear Harriet, be thankful for the blessing of sight, of which so many are deprived, and for which, if restored, they would doubtless be far more grateful than we are, who constantly enjoy the pleasures it brings. Adieu.

LETTER XII.

I SHALL next, my dear friend, call your attention to a race which offers a striking example of perseverance and industry, and which even more than those which live in great societies show us what those qualities can effect. They do not, as we all too often do, shrink from difficulties and supinely content themselves with doing only what is easy, but unassisted, for the most part, they perform their task, and in general it is an arduous one.

The bee species is not confined to those which make honey and wax; there are many other kinds, which not being useful to man, are scarcely known, though very common.

The hive we may compare to a large and populous city; the wasp's nest, or vespiary, to a country town; and the humble bee's nest to a village. Those who live alone may be compared to savages, who depend not on the assistance of others.

The wasps, which are universally disliked as

bold and annoying robbers, are not quite so disagreeable or unamiable as they appear; they are brisk and lively, do not attack unprovoked, and generally rob us to feed their young ones.

Their societies consist of females, males, and workers. The large females are as large as six of the workers, and lay both male and female eggs. The small females are as large as the workers, and lay only male eggs. The queen wasp founds her colony and does all the work till the young ones can assist her; yet in the autumn the vespiary sometimes contains 16,000 cells: even at this time, with so much help, she sets an example of diligence to the whole community. The male wasps are much smaller than the females, being about twice as large as the workers. They are not quite idle, for they are the scavengers of the community, and sweep the passages and streets, carrying off all the filth. They also remove the dead bodies.

The workers are the most numerous, and to us the only troublesome part of their society. In the summer and autumn they go forth by myriads to forage the country, and on their return, after reserving sufficient for the young brood, they divide the spoil with great impartiality. Another employment for them is

the repairing and enlarging of the nest. Each individual has its portion of work assigned, from an inch to an inch and a half, and is furnished with a ball of ligneous fibre, scraped by its powerful jaws from posts, rails, &c. They all perish on the approach of the cold season, except a few of the females, who remain torpid.

Reaumur made a glass hive for them, and was thus enabled to watch their proceedings, without offending them, which we know is no very easy task.

We now come to the villagers, which the humble bees may be truly called. They live in companies of fifty and sixty, in a rustic-looking habitation. They are much larger than the hive bee, and fly about with a much louder humming. They are divided into four orders; large females, small females, males, and workers. The first, like the female wasps, are the original founders of their republics. They come out in the autumn, and pass the winter, as appears from an observation of Huber's, in a particular apartment separate from the rest, and rendered warm by a carpeting of grass and moss, but without any food.

If they do not find a hole ready for their nest, they make one in the ground, which is prin-

cipally destined to hold the young ones; there is nothing remarkable in its appearance, being like a mound of earth covered with moss; but on examination this moss is found to be composed of a great quantity of filaments and fibres, brought and curiously interwoven by the bees, in such a manner that the rain cannot penetrate. Sometimes they add a thin coating inside, of the same substance of which honey-combs are made, and under this vault are piled two or three combs. They feed the young ones with a paste made of pollen and honey, but the males and females are fed with pure honey, like the hive bees. The mother puts her egg into a certain portion of this paste; so that when the grub comes out it has nothing to do but to eat. It is probably to moisten this paste that they keep a provision of honey, which they put into the empty cocoons of the grubs, though sometimes they form little honey-pots like goblets.

I cannot refrain from relating an anecdote which particularly struck me. In the course of his ingenious experiments, M. Huber put under a bell-glass about a dozen humble bees, without any store of wax, along with a comb of about ten silken cocoons, so unequal in height, that it was impossible the mass should stand firmly.

Its unsteadiness disquieted the humble bees extremely. Their affection for their young led them to mount upon the cocoons for the sake of imparting warmth to the inclosed little ones ; but in attempting this, the comb tottered so violently, that the scheme was almost impracticable. To remedy this inconvenience, and to make the comb steady, they had recourse to a most ingenious expedient. Two or three bees got upon the comb, stretched themselves over its edge, and with their heads downwards, fixed their fore feet on the table on which it stood, whilst with their hind feet they kept it from falling. In this constrained and painful posture, fresh bees relieving their comrades when weary, did these affectionate little insects support the comb for nearly three days ! At the end of this period they had prepared enough wax, with which they built pillars that kept it firm ; by some accident the comb was again unsettled, and they performed the same manœuvre till M. Huber took compassion on them and propped it up.

There is a solitary bee which I shall mention first as having apparently an elegant taste. Reaumur calls her the tapestry bee. She invariably chooses for the hangings of her cell the leaves of the bright scarlet poppy, and seems to

disdain a more homely colour. She first makes a hole in the ground, which she polishes and makes quite smooth ; then cutting out oval pieces of the poppies, she returns and fits them to the walls, smoothing the wrinkles, and cutting off the superfluous parts. She puts three or four layers on the bottom and two at the sides. Then filling it about half an inch deep with honey and pollen, and committing an egg to it, she wraps over the poppy-lining, and fills it up with earth.

The solitary bee pierces a hole in wood which is sometimes twelve or fifteen inches long, and large enough to admit of her free entrance. For this purpose she generally attacks old dry wood, as posts, &c. and sometimes thick doors or gates. It appears a formidable undertaking for so small an insect to hollow out and clear away twelve or fifteen inches of wood, yet that is merely the case of the nest. She is then obliged to divide it into cells, of which every one is seven or eight lines high, and is destined for one maggot ; they are separated by a kind of ceiling, which is made after the maggot is deposited in the cell ; but not content with providing a dwelling, she also gives it a certain quantity of food. This food is the paste of pollen and honey, and when she

has collected enough, she puts it in and closes the cell. When the maggot has consumed its food, it changes to a nymph, and afterwards to a bee. We may call these the *carpenters*, and those of which I shall next speak, the *masons*; they make very good mortar for building their nests, which are collections of cells under one cover. They prefer attaching them to walls exposed to the sun, but though they are often as large as half an egg cut longways, they are generally passed over as a lump of mortar or mud; but when examined, eight or ten cavities, more or less, are discovered, some filled with very small maggots in a quantity of paste, others with large ones and little paste, and others with nymphs and bees. These cells are in the form of a thimble with an egg at the end, and are quite filled up with paste, and stopped at the large end. When this is done, the bee (for it is all performed by one) fills up the spaces between the cells with rougher mortar. This substance is like ours, chiefly composed of sand, but mixed with a little earth; however, she does not make use of lime as we do, but substitutes a glutinous liquor from her mouth. After having made a little lump, she carries and fixes it with her teeth. What indefatigable industry must be

required in this work, and how hard we should consider our case if obliged to such unremitting labour! nevertheless those who studiously endeavour to perform all their duties will find almost as much to do as the bees, though in a more varied and amusing manner, it must be confessed.

Another kind of bee constructs her nest in a quite different manner, and with still greater address. She is hardly so large as the common bee, and hides her admirable work underground. The materials are simple, being merely pieces of leaves from the mulberry-tree, elm, rose-tree, &c. The exterior of each nest resembles a toothpick case, both in size and form, being a tube rounded at the ends. Its natural position is horizontal, and some inches under the surface of the earth; therefore the first labour of the bee is to hollow a hole for its reception, which in itself requires strength and patience. The nest itself is formed of a number of pieces of leaf, of an oval form, folded and adjusted one over the other. If this envelope is taken off, we discover a number of smaller cases, made in the same way, like small thimbles with the smaller end slipped into the open part of another. Each of these is a cell where the maggot is to live, and at the same time a vase

for the honey it is to feed on ; so that it must be carefully stopped, and perhaps you would not guess how. When a cell is finished, the bee deposits the egg, and fills it up with honey ; but as the nest is placed horizontally it would run out ; she therefore takes the simplest and best mode of preventing it, by cutting from a leaf a round piece of the exact size, which she fits into the edge of the little vase, and to make it sure adds two more. To obtain these round pieces, she flies to a proper leaf, and seizing the edge with her feet, cuts a round piece with her teeth quicker than we should do it with scissors. It is very singular how she should be able to remember the exact size, which we should find difficult or even impossible. Like most other insects, the female only has a sting. Reaumur first became acquainted with these bees in rather a singular manner, which he has related in his *Memoires*, and which may amuse you. In the beginning of July, 1736, the lord of a village on the Seine, near Rouen, came to the Abbé Nollet, accompanied by several people, and his gardener among others, who appeared in great consternation. He had come to Paris to tell his master that the garden was bewitched, and though he apprehended the most dreadful consequences,

had actually the courage to bring with him what he considered proof sufficient for the whole world, and which had even deceived the minister himself. At the sight of these terrible things, his master, though not quite so much alarmed as himself, was surprised, and consulted his surgeon, who knowing more of his own profession than of natural history, referred him to the Abbé Nollet as more capable of solving the mystery. The gardener brought the roll of leaves, which he firmly believed to have been made by a wizard, and with some very bad intention; for why else should any one take so much trouble? Happily M. Nollet had by him some similar rolls made by beetles, which he showed to the man, assuring him they were formed by insects, as, no doubt, his own were. He opened one of the cells on the spot, and showed the maggot to the man, who certainly had never dared even to think of prying into them; his sombre and anxious countenance instantly cleared up, as if he had been delivered from some great danger.

One species of solitary wasp has a very curious manner of building or rather digging her nest. These insects are rather smaller than the common wasp, and are chiefly black with yellow stripes. They may be seen at work in June on

walls built of flint and mortar. Although their object is to make a hole, it appears quite otherwise ; for they raise a kind of hollow tube of the earth they dig out, and which is sometimes two inches long ; it is not however made to last, being only a kind of scaffolding or bulwark till the work is done. You may perhaps wonder how this insect can penetrate so hard a substance as dried clay or mortar ; but she is provided with a liquor in her mouth to soften it, and this serves to make the particles of earth, of which the tube is made, stick together. When this liquor is exhausted she fetches water, or probably some juice of plants, and proceeds with her work. This is performed so rapidly that one has been observed to dig, in about an hour and a half, a hole equal to the length of her body, and to raise the tube in proportion. We need not ask why this hole is made, for we must conclude it is for the reception of her egg and the provision for the maggot ; but it does not appear at first why the tube has been made with so much care ; but the more we see, the more we shall be convinced that there is nothing useless in nature, and the less we shall be inclined to judge hastily. When the egg and its provision are lodged in the bottom, this tube is to her what a heap of bricks is to a

mason, and she pulls it to pieces to stop up the hole again. You may perhaps object that it would be as easy to lay it in a heap at once; but no one will deny that order is better than confusion, and it is quite as little trouble to carry the particles and arrange them regularly as to throw them down and have the greater trouble of picking them up again; besides it serves as a bulwark, for often when she is flying abroad, the ichneumon fly might deposit in the hole an egg, which would become the deadly enemy of hers, and while this fortress stands her absence cannot be so well ascertained. When the cell is finished, and the egg laid in it, the careful mother has next to supply food for the future maggot; and as they are carnivorous, perhaps you would never guess how she provides for twelve or more days. When the hole is opened it is found full of green grubs, curled round and piled on each other, to the number of ten or twelve. Their backs are placed against the side of the hole; and as they are pressed closely together, cannot move, though quite alive. These grubs are of an opaque green, and always of the same species in each nest, or rather den. The wasp-maggot is yellow, and increases in size as he eats his prey, which he does in the following manner:

He begins at the nearest, and having sucked out the inside, draws the skin and head to the bottom of the cell, and begins another ; thus he proceeds with all, devouring one each day, and then spins himself a cone. This is rather remarkable — the green grubs seem all of the same age, and live all this while without eating ; doubtless the mother wasp chooses them at a time when they are in a state of torpidity previous to their change, when they would desire nothing better than to lie quiet, which however they would be obliged to do from the manner in which they are piled. As it would be impossible for the wasp to convey them rolled up through the tube, she stretches them out, and carries them in her feet under her own body. When laid down, they naturally roll themselves up, and lie quiet, though doubtless without guessing why they are brought.

Another wasp of about the same size hunts another kind of game for her young ones, which certainly appears rather singular, for she catches *spiders*, which have always been considered their most potent enemies. In some holes seven or eight have been found always of the same species. Some ichneumon wasps feed their maggots with flies ; and if the holes are opened they will be

found strewed like the dens of wild beasts with legs, wings, heads, and other remains of their unfortunate victims; but the maggot does not let them lie useless, as he uses them to make his cone more substantial.

Many kinds of wasps are wood piercers. Reaumur had a piece of old wood in which, on splitting, he found many cavities filled with pretty flies and an oblong yellowish egg. Having split it still further, he found many others of different kinds, but each cell had but one kind of fly in it, though some had little caterpillars. Perhaps many pieces of old wood, which we push aside in walking, contain these curious and ingenious fabrications.

There is a beautiful wasp in St. Domingo, which is of a brilliant golden green or blue, with legs of a fine violet colour. They fly with great agility, and are very fearless; they are likewise very difficult to take, as their sting is much more formidable than any common wasp or bee, and much longer. They wage continual war with the cock-roaches, which are very destructive in that country. When the wasp perceives one she stops a moment, but soon darts upon her helpless prey, and seizing its head with her teeth, attempts to sting it in the softest

part; when this is done she leaves the victim and flies about, sure of finding it in the same place. The poor cock-roach has then lost all power of resisting its fierce enemy, who drags it backwards to her hole; but if that is too far off, she takes two or three turns in the air by way of rest, and then proceeds: if the hole is too small to admit it, she bites off its legs or wings. It is high time to finish this long letter, so I shall leave you to make your own reflections on it, till I write again. Adieu.

LETTER XIII.

MY DEAR HARRIET,

It is not day alone which presents to our view the wonders and beauties of creation ; there are many insects which adorn the dark robe of night with their diamond lustre ; and in hot countries, where evening is the season of activity or pleasure, they are as useful as they are beautiful. I allude to those insects which are furnished with a luminous secretion, incapable of burning, though affording a very vivid light. The glow-worm, which is a common and beautiful example, resembles a caterpillar, but is, in reality, the perfect female of a winged beetle, which in many instances, particularly in *Lampyrus splendidula* and *L. hemiptera*, is adorned with two or four luminous spots, which are seen when flying, though not always, as they have the power of withdrawing them from sight. The females also have the same faculty, which is necessary for their safety, and probably accounts for their not being always found in places where they usually abound. The light proceeds

from the three last ventral segments of the abdomen, but sometimes appears above, between the dorsal segments or rings. Though most of the females of the different species of *Lampyris* are without wings, all are not so unfortunate; the female of *Lampyris Italica*, which is common in Italy, and has even been caught in Hertfordshire, is winged.

Elater noctilucus, an insect of the beetle tribe, is luminous in a higher degree. It is about an inch long, and gives its principal light from two tubercles placed upon the thorax, or upper part of the body; but there are also two luminous spots under the wings, which show when the insect flies, and give it a very beautiful appearance, particularly as, when the body is stretched, it seems filled with light, which shines out between the segments. This light is so brilliant, that the smallest print may be read by moving one of them along the lines; and in the West Indian islands, the natives used to employ them as lamps: when travelling, they would tie one to each great toe, and needed no other light. These useful insects, which they call Cucuij, are also extremely beneficial by destroying the gnats, which you know are such a pest in those countries: for this purpose they catch the fire-

flies, and bring them into their houses. Besides these there is a genus in the order *Hemiptera*, called *Fulgora*, which have the English name of lantern-flies, from the circumstance of their light proceeding from a hollow sub-transparent projection of the head. In *Fulgora candelaria*, a native of China, this projection is of a sub-cylindrical shape, curved back at the point, above an inch in length, and of the thickness of a small quill, from which the insect emits a very powerful light. In *Fulgora laternaria*, a native of South America, which is two or three inches long, this snout is much larger and broader, and sheds a transcendent light. Madame Merian informs us, that it is quite bright enough to read a newspaper by. There is another species, *F. pyrrhorynchus*, which must be still more beautiful than this, as the projection is of a rich deep purple from the base nearly to the end, which is of a fine transparent scarlet. There is also a species of scolopendra (*S. electrica*), commonly called centipedes or hundred-legs, which are luminous, and very common in this country; they may be found under the earth, and are very visible at night. The mole-cricket, which is a very scarce insect, is said to be luminous. The light in the glow-worm, and in *Elater noctilucus* and

ignitus, proceeds from masses of a substance not generally differing, except in its yellow colour, from the rest of the body, closely applied under those transparent parts of the skin where the light is seen. In the glow-worm, besides the last-mentioned substance (which, when the season for giving light is passed, is absorbed and replaced by the common substance), Mr. Macartney observed, on the inner side of the last abdominal segment, two small oval sacs, formed of an elastic spirally wound fibre, similar to that of the tracheæ, containing a soft yellow substance of a closer texture, and affording a more brilliant light, less under the control of the insect than the other luminous parts, which it has the power of voluntarily extinguishing, not by retraction under a membrane, as Carradori imagined, but by some inscrutable change dependent upon its will. There have been various and contradictory opinions upon the immediate cause of this luminous property, and many experiments made with very opposite results; so we must conclude it uncertain, and be content with admiring the effect. As I have nothing more to say on this subject, my dear friend, I will conclude for the present; but it will not be long before I write again.

LETTER XIV.

THERE is something very singular, my dear Harriet, in the history of a species, called, by Reaumur, *Gall insects*, from their resemblance to galls. At the time of their birth, and for some days after, they are extremely small and very active, running about the leaves and branches. They are then something like small wood lice, but they soon fix themselves and remain motionless, and in this inanimate state they increase in size prodigiously, and appear like tubercles on the back. Some are as large or larger than peas, and others as small as grains of pepper. Some are circular, others semicircular, and others oblong. They lay thousands of eggs, but keep them under their bodies, thus sitting over and in a manner hatching them; and when the mother dies, which happens soon after, they find shelter and safety under the dried shell of her body, which remains fastened to the back, and serves them as a house, having a little glass in one part, which is the door. I have

seen a great number on a vine, in the greenhouse, of an oblong shape. The male is a beautiful little fly, the body, head, and legs of which are of a deep red; the wings are very large in proportion, semi-transparent and whitish, with a border of bright red, which is their greatest ornament. On the tail, which is long and pointed, are two white filaments twice as long as the wings. It is singular that there should be so striking a difference between individuals of the same species, but it is not the only instance; the glow-worm is a similar one.

I should have told you that they change their skins or rather shells, but in a different manner from other insects. They make various movements and contortions, which split the outer surface into thin transparent laminæ or flakes, which fall off; but as they are extremely slow in their motions, this takes a long time to perform.

The Cochineal insect, the Kermes, or *Coccus Baphica*, are of this species; but Reaumur calls them *false Gall insects*, from some differences peculiar to them. The Cochineal, which is one of the greatest objects of commerce in Mexico, and is cultivated in that country alone, feeds on a plant known by the names of *opuntia*, Indian

fig, or N. opal, from the juice of which it is supposed to derive its beautiful colour. Perhaps the manner in which the Indians reap this curious and profitable harvest may amuse you. Round their habitations they plant the N. opal, from which they expect many crops of the insect in the year. The last is gathered when the rainy season approaches, for bad weather is very destructive to them, and to preserve enough for the next year the Indians cut off the leaves on which are the young insects, and carry them into their houses to keep them dry, and as the leaves are very succulent they do not soon wither. The insects thus sheltered are nearly arrived at perfection when the rainy season is passed. They are then in a manner sowed. The Indians make little nests of moss, in which they place twelve or fourteen insects, and put them between the leaves, or as they call them the *pencas*, sticking them on the thorns. In three or four days the young ones are born, for we must remark that they do not lay eggs like the other gall insects. They are produced by thousands, and are, at first, no bigger than a pin's point (at least it is said so, but we must suppose it rather blunt), and soon dispersing in every direction, begin sucking the plant in the spot where they fix,

and where they soon attain their full size. At this time the Indians scrape them off with their long nails, leaving all the young ones already born, which in two or three months afford another harvest. After this the rainy season returns, and the Indians collect the young ones of this last gathering to take under shelter. The cochineal of the first gathering is esteemed the best, and produces the finest colour.

The Indians kill the insects, as soon as they are collected, in various ways. Some put them in a basket which they plunge into hot water, and after dry them in the sun. Others have small ovens in which, when heated, they spread them on mats: these ovens are called *temascales*. The Indian women bake their loaves and cakes of maize on plates over a fire, and they sometimes use these, which are called *comales*, to kill the cochineal, and on these different ways principally depend the colour and quality. The best are those covered with a whitish powder, and these are baked in the ovens.

The *Coccus polonicus*, or Kermes of Poland, is found on the roots of a plant, the *polygonum cocciferum*, *Caspari Bauhini*. Towards the end of June is the proper time for gathering. Every

grain is then nearly round, and of a violet purple. Some are not larger than poppy seed, and others are as large as peppercorns. Each is half enclosed in a kind of cup or calix, like an acorn, which like that is rough outside and smooth within. From the large grains, which are the females, proceed grubs with six legs and two antennæ. In about a fortnight they remain motionless, and their bodies become covered with a cottony secretion, like down, extremely white and fine. This down forms a kind of roof, which is sometimes round and sometimes irregular. They remain in repose, and covered with this down, for five or six days, during which each lays about a hundred and fifty eggs, or more, which are found mingled or enveloped with the down; and indeed this seems its principal use. Afterwards they die. Each of the smallest grains, which are the males, produces a grub towards the end of June, sometimes covered with down and sometimes not, which turns to a nymph or grub chrysalis, and remains motionless till towards the middle of June; it afterwards turns to a small winged fly, like that of the cochineal.

There are many other kinds of this insect, which however nearly resemble each other, so

I shall say nothing of them. I do not know whether the species which infests the vine is to be found in the open air; but if you have an opportunity of seeking them in a greenhouse, you may easily watch their growth. Adieu. I shall soon write again.

LETTER XV.

I BELIEVE, my dear friend, that I have not yet mentioned several insects, which have a very unjust prejudice and dislike attached to their names, therefore I intend to expatiate a little upon these unfortunate victims of calumny, and try to vindicate their fame. Spiders are in some respects very amiable ; for instance, they will expose their own lives to protect their young ones. This wonderful attachment Bonnet put to a decisive test. He threw a spider with her bag of eggs into the pitfall of a large lion-ant, a ferocious insect which conceals itself at the bottom of a hole, and whose history I shall presently give you. The spider endeavoured to run away, but was not sufficiently active to prevent her bag from being seized, and pulled under the sand by her enemy. She struggled to prevent this with all her might, and when the bag gave way from its fastening, she seized it with her jaws, but in vain ; the lion-ant was the stronger, and dragged it under the sand. The unfortunate

mother might have preserved her own life by escaping, but she rather preferred being buried alive with her treasure, and it was only by force that Bonnet withdrew her from the danger, and though he pushed her away with a twig, she still remained on the spot, and appeared inconsolable.

What can be more astonishing than the discoveries made by Leeuwenhoek's microscope? He calculates that the threads of the smallest spider, some of which are not larger than a grain of sand, are so fine that four millions of them would not equal one hair of the beard. Each of these threads is formed of four thousand others, the fineness of which it is impossible to conceive; but I should first describe the spinning apparatus. Under the spider's abdomen there are four or six little orifices or spinners, every one of which is furnished with a multitude of tubes, so numerous and so exquisitely fine, that Reaumur counted a thousand in a space not bigger than a pin's point. From each of these proceeds an inconceivably fine thread, which immediately unites with all the rest. Four of these threads again unite lower down, and form the common one we see in the webs, which though sometimes nearly invisible,

is composed of at least four thousand others! The house spider fixes her thread to one side of a corner, and walking along the wall to the other, draws it across and fixes the other end. This thread she renders strong by repeating the operation two or three times, and then draws threads from it in various directions, the interstices of which she fills up by running from one to the other, and thus connecting them. You may often see the garden spiders at work in the mornings of autumn, and it is highly amusing to watch them. They often have to extend their main line across places apparently unconnected, between branches of trees, between buildings, and even plants growing in the water. The way in which they perform this is shown by putting a spider on the top of a stick, having the lower end in a vessel of water. After trying all other modes of escape, it will dart out numerous fine threads, so light as to float in the air, some one of which attaching itself to a neighbouring object, furnishes a bridge for its escape. This is probably the means by which the geometric spiders form their astonishing webs. The threads of the house spider's web are all of the same kind of silk, but the garden spider's is composed of two sorts; the radii are not ad-

hesive or sticky, but the circles are. If examined with a microscope, they will be found studded with little shining drops like dew, formed of a viscid gum, which catches the insects that alight upon it, like bird-lime. M. Q. D'Isjonval asserts, that the geometric spiders are always regulated by the future probable state of the atmosphere, and that if the weather is about to be variable, wet, and stormy, the main threads which support the net will certainly be short; but if fine settled weather is commencing, they will as invariably be very long. A prisoner of war in France, I believe, amused himself with watching his spiders, and foretold many very important changes of the weather; indeed, if I recollect right, his little barometers procured him his freedom at last.

There are many others which do not trouble themselves with making webs, but catch their prey openly, or rather, I should say, in a less artificial manner. *Aranea atrox* lurks in holes; *Aranea calycina* places herself at the bottom of the calix of a dead flower, and pounces on the unwary flies that come for honey; *Aranea arundinacea* buries herself in the thick panicle of a reed. Among the hunters the immense *Aranea avicularia*, two inches long, is the principal; it

lives in the South American woods, and was said to catch even small birds, but this has been denied by Langsdorf.

One spider actually makes a room, with a door turning on a hinge, however surprising it may appear to you. This room is a subterraneous gallery, upwards of two feet in length, and half an inch broad. This tunnel, which is very large compared to the insect, is dug by her strong jaws in a steep bank of clay. The next operation is to line the whole with a web of fine silk, which serves the double purpose of preventing the earth from falling in, and by its connexion with the orifice, giving notice of what is passing. The door is formed of several coats of dried earth, fastened together with silk: when finished, its outline is as perfectly round as if traced with compasses; the inside is convex and smooth, the outside flat and rough, and so like the surrounding earth as not to be distinguishable. This door the ingenious spider fixes at the entrance by a hinge of silk, which allows it to be opened and shut with ease; and as if acquainted with the laws of gravity, she invariably fixes the hinge at the highest side of the opening, which you may remember is sloping, so that the door, when pushed up, shuts again with its own weight.

She also leaves a little edge or groove, just within the entrance, upon which the door closes, and fits with the greatest precision. If the door is a little raised, the observer immediately feels a strong resistance, which is the spider pulling with all her might to keep it close; but when she finds it in vain, she runs off. If the door is fastened down, there will be a new door the next morning. This singular habitation is merely an abode for the spider, which hunts in the night, and carries the prey to devour at leisure at the bottom of her den, where the remains are often found. This species is not uncommon in the south of France.

We must not pass over the aquatic spider, who builds her enchanted airy palace under the water. First she spins loose threads, in various directions, attached to the leaves of aquatic plants, and spreads over them a transparent varnish, which issues from the middle of her spinners, and is so extremely elastic, that if a hole be made, it instantly closes again. Next she spreads over her belly a pellicle of the same, and ascends to the surface; it is not exactly known how she conveys a bubble of air under this pellicle, but it is supposed that she draws it in, and pumps it out, from an opening in the middle

of her body. Clothed with her garment of air, she dives to the bottom, and transfers it beneath the prepared roof. She repeats this till the roof is raised by the quantity of air underneath, when an apartment is formed between the inner surface of the roof and the water below it; and here she lives quite at her ease, like a sea nymph in her enchanted cave. Both sexes form these abodes, and sometimes share them with each other, living peaceably together. This is the largest European species.

Of all kinds, however, I think the flying spiders are the most curious. If you have never heard of them before, you will doubtless be surprised that any creature can fly without wings; yet they may truly be said to fly in their chariots of gossamer, in which they quietly repose, and catch their prey as they sail along. Dr. Martin Lister observed these webs falling from the sky, and discovered in them more than once a spider. On another occasion, while he was watching a common spider, it suddenly turned upon its back, and darting forth a long thread, vaulted upwards, and was carried to a considerable height: he further discovered that while they fly in this manner, they pull in their thread with their fore-feet so as to form it into a ball; in

this way they go to a great height. One day in the autumn, he went upon the highest steeple of York minster, from which he saw the floating webs still very far above him; some spiders fell down, and he found they were of a species which never enter houses. Many kinds have this faculty, though only in their youth, or half-grown state. Mr. White witnessed a shower of these gossamer webs, the account of which may amuse you. On the 21st of September, 1741, he rose before daybreak, and on going out, found the whole country covered with cobwebs drenched in dew, as if two or three nets had been drawn over it. When his dogs attempted to hunt, their eyes were so blinded that they were obliged to lie down and scrape themselves. This appearance was followed by a very fine day; and about nine o'clock a shower of webs, in flakes near an inch broad, and five or six long, was observed to begin, and continued falling all day with considerable velocity. The flakes hung so thick in the trees and hedges, that baskets full might have been collected. The use of these air-borne chariots seems to be, to enable the spiders to catch the small flies which live high in the atmosphere, for their remains are often found in them.

If you share in the common and unjust prejudice against earwigs, you will perhaps be induced to think more favourably of them when I tell you that they guard and sit over their young ones with all the care and affection of a hen. De Geer having found an earwig sitting on her eggs, removed her into a box, in which was some earth, and scattered the eggs in all directions; she soon, however, collected them together, and sat upon them as before. The young ones, which are like the mother in all but her wings, and, strange to say, are, as soon as born, larger than the eggs which contained them, immediately upon being hatched, creep like a brood of chickens under the mother, who very quietly suffers them to push between her feet, and will often, as De Geer found, sit in this posture some hours. Does not this fact make this poor little insect appear in a very amiable light? Perhaps you may not know that earwigs have large wings, very curiously folded up in small cases or elytra, like those of beetles; they cannot, however, fly in the day-time.

The lion-ant, which is an inhabitant of the south of Europe, is a most extraordinary insect, and its curious proceedings have been minutely detailed by Reaumur: it is the larva of the insect,

whose history I shall give you. It belongs to a genus between the dragon-fly and the heme-robins; its length is about half an inch, and in shape it resembles a woodlouse, though more triangular: it has six legs, and the mouth is armed with curved jaws like horns. It lives upon the juices of other insects, chiefly ants; but as it always walks backwards and very slowly, you may perhaps wonder how it gets any food, particularly as it will not touch any animal it has not previously killed, and then only sucks the juices; but you will no longer wonder when you hear of its admirable stratagem. It digs a conical pit in loose sand, at the bottom of which it lies concealed to seize upon the unwary insects that, going too near the brink, fall down the sides. It first finds a soil of loose dry sand, near which it is indeed generally placed by its mother, and near some old wall or tree; it next traces a circle in the sand, and proceeds to hollow it, by standing on the inside of the circle, thrusting the hind part of its body under the sand, and using its fore-leg like a shovel to load its flat square head, with which it jerks the sand outside to the distance of some inches. Walking backwards, and constantly repeating this process, it soon goes round the circle, when it proceeds

in another with equal address. We must remark, that it never loads its head with the sand *outside* the circle, but constantly uses the leg next the centre, as if knowing that it is the middle only that is to be excavated; and as one leg would soon be fatigued with the labour, it turns round, and traces the next furrow in the opposite direction. It often meets with small stones which it puts on its head and jerks out; but if a pebble presents itself which is too large for this, the insect, by a particular manœuvre, lifts the stone on its back, keeps it steady by the motion of its segments, and walking up the side, lays it down on the top. When the stone is round, this task becomes very difficult; but the patient insect has been seen to make six unsuccessful attempts, and only accomplished it on the seventh: if it finds its endeavours fruitless, it abandons the pit and forms another. This pitfall is rather more than two inches deep, about three inches wide at the top, and contracting to a point at the bottom. The lion-ant takes its station at the bottom, being concealed under the sand, all except the points of its expanded forceps. Soon some unlucky ant runs on the edge, perhaps to look down, but the sand slides under her feet, and her struggles only hasten her descent; though if she should

be able to stop midway, her cruel enemy, who has six eyes on each side of his head, throws showers of sand from the bottom, which soon precipitate her into his jaws. These admirable instruments are at the same time hooked for holding, and hollow for sucking, and thus he regales himself at his ease: the dry carcass he jerks out, and then resumes his station. The insect remains two years in this state, and then retiring under the sand, spins a cocoon, and after remaining a chrysalis a few weeks, comes forth a four-winged insect resembling the dragon-fly, and preying in the same manner on moths, butterflies, and other insects.

The larva of *Rhagio vermilio*, which resembles a maggot, also makes use of this stratagem, with but little variation. Thus, my dear Harriet, we see that nothing in nature is forgotten by a merciful Providence; and though we cannot, with our limited understandings, conceive why the law of nature should be destruction, or why even insects cannot live without inflicting death on other creatures, yet let us not presume to arraign, even in thought, the inscrutable ways of that Being who is himself incomprehensible.

You may perhaps be surprised that I have not mentioned snails, &c.; but I believe they do not

properly come under the class of insects. Linnaeus distinguishes them by the name of soft bodied animals either with or without shells, so we have nothing to do with them, particularly as I have been obliged to omit so many of the almost innumerable kinds of insects.

Though our correspondence must close here for the present, I may perhaps resume the subject if I have an opportunity, and if you wish it; though my object has been chiefly to induce you to pursue your inquiries in a more regular manner and from more competent authorities.

I trust, my dear friend, that you will verify the remark, that “the more we know, the more we wish to know;” and also that your just admiration of the beauties and excellencies of nature will lead you to that deep and habitual reverence of its great Author, which alone can ensure you peace of mind through the changes of life. Adieu!

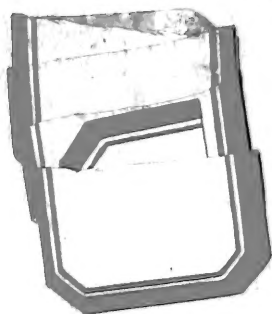
THE END.

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